NATURE

No. 4171 SATURDAY, OCTOBER 8, 1949 Vol. 164

CONTENTS

	Page
Local Government in a Democracy	591
Electronic Circuits. By Dr. R. A. Smith	594
Metallurgy for Engineers. By A. J. MacDougall	595
Progress in Physiology	595
Chemistry and the Food Supply	597
Measurement and Trend of Intelligence	598
New Developments in Interferometry. By H. Barrell	599
The Scientific Department of the National Gallery. By F. I. G. Rawlins and A. E. A. Werner	601
Obituaries:	
Mr. A. H. Hall, C.B., C.B.E. By W. G. A. Perring, C.B.E.	603
Prof. W. B. Morton. By Prof. K. G. Emeleus	604
News and Views	604
Some Aspects of Bone Marrow Metabolism. By Dr. C. Lutwak-Mann	607
Science in Adult Education	608
Psychology and Teaching	609
Institut Pasteur de Kindia, French Guinea	610
Marine Biology in Britain. By G. A. Steven	611
Fourteenth International Veterinary Congress	611
Letters to the Editors:	
Absorption of Metallic Cobalt-60 from a Subcutaneous Site.—M. Nickson, L. F. Lamerton and Prof. W. V. Mayneord	613
Preparation of Radioactive Hydrogen Sulphide.—U. Croatto and Dr. A. G. Maddock	613
'Long-Term' Adaptation and Non-Mendelian Inheritance in Yeast.—Balaji D. Mundkur	614
Photoperiodism and Diapause in Insects.—M. J. Way, B. Hopkins and P. M. Smith	615
Growth and Sinus Glands in a Crab.—A. Bauchau	615
Immigration of Algæ in Danish Waters.—Sören Lund	616
Piercing Mouth-Parts in the Biting Lice (Mallophaga).—Theresa Clay	617
Modification of the Ectoderm in *Sphenodon*.—Alan Fisk	617
Natural Epizootics of *Polystoma integerrimum* in Tadpoles.—R. Maxwell Savage	618
Enzyme Activity and Nitrogen Content of *E. coli*.—Dr. J. De Ley	618
Mechanism of Propionic Acid Formation in Bacterial Fermentation.—Dr. A. T. Johns	620
Inositol and Phosphorylation of Liver Lipids.—M. Blewett, I. G. Campbell and June Olley	621
Crystalline Derivatives of the Polymyxins and the Identification of the Fatty Acid Component.—Dr. S. Wilkinson	622
Crystallizable Recombined Hæm–Globin from Human Red-Cell Hæmoglobin.—E. M. Jope, H. M. Jope and J. R. P. O'Brien	622
Formation and Distribution of Vitamin C in the Radicle and Cotyledon of the Broad Bean (*Vicia faba*).—A. C. Shaw and L. C. Pascoe	624
Concentration and Distribution of Polysaccharides in Human Cortical Bone and the Dentine of Teeth.—Dr. H. J. Rogers	625
Enzymic Inactivation of Serum Gonadotrophin.—R. Friedmann	626
Plastic Deformation of Glass during Scratching.—Dr. J. F. H. Custers	627
Strength of Metals.—Dr. W. A. Wood; Dr. H. Lipson and Dr. A. R. Stokes	628
Origin of Hygroscopicity of Jute.—Dr. M. K. Sen and Dr. P. H. Hermans	628
Goethe and Colour.—Dr. R. Weale	629

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

All rights reserved.

Registered as a Newspaper at the General Post Office

LOCAL GOVERNMENT IN A DEMOCRACY

"LOCAL assemblies of citizens constitute the strength of free peoples. Town meetings are to liberty what primary schools are to science; they bring it within the people's reach, they teach men how to use and enjoy it. A nation may establish a system of free government but without the spirit of municipal institutions it cannot have the spirit of liberty."

This quotation from A. de Tocqueville's "Democracy in America" with which Mr. V. D. Lipman opens his study, "Local Government Areas 1834–1945"*, recently made under the auspices of Nuffield College, points to the real reason for concern over the Government's sudden decision to terminate the Local Government Boundary Commission while making no alternative proposal to deal with the problems outlined in the White Paper of January 1945 on "Local Government in England and Wales during the period of Reconstruction", or with the subsequent recommendations of the Boundary Commission itself. Mr. Lipman's study concludes with the appointment of that Commission, and he reviews neither its activities nor its recommendations, although his survey led him to regard the appointment of the Boundary Commission as marking the opening of a new stage in the development of English local government areas. Nevertheless, his admirable marshalling of facts leads to the enunciation of principles which should guide the administrator as well as assist in the formation of a sound judgment on the wisdom of the Government's recent decision and on the requirements of future policy.

The function of local government as an instrument of civic self-education is one of the two main purposes of local government as it is understood in Britain; and it is the one from which the vitality of local government is mainly drawn. It is only as the citizen sees himself as able effectively to influence what is taking place in his local community and understands what is being done that he will be sufficiently interested to play his part. To the extent to which the measures required to serve the second purpose of local government—the administration of public services—hinder the participation of the citizen in local government or diminish his interest, they endanger one of the mainsprings of liberty in the modern State. The continuing whittling down of local government, largely in consequence of Government policy in regard to the administration of health and other services, is a grave danger to local democracy to-day and threatens the effective working of democratic institutions upon a national scale also.

To this danger the Local Government Boundary Commission was fully alive. Its second report, issued last year, was first and foremost an indictment of the neglect to deal with the reconstruction of local government, of the policy of drift and of allowing piecemeal alteration of the responsibilities of local government authorities to distort the structure so

* Local Government Areas 1834–1945. By V. D. Lipman. Pp. x+506. (Oxford: B. Blackwell, 1949.) 25s. net.

that it becomes less and less suitable for its task. In its third report, for the year 1948, the Commission reiterated its earlier conclusion that in the areas covering the great bulk of the population its present powers and instructions did not permit the formation of local government units as effective and convenient as in its opinion they should be. Five important questions raised in its first and second reports to which the Minister of Health had given no answer were again pressed in November last, but the Minister replied on March 29, 1949, that the Government had decided it would not be practicable to introduce comprehensive legislation on local government reconstruction in the near future. The Commission thereupon indicated its intention to select cases in which a formal order would be both appropriate under the existing statute law and general principle, and also, as far as it could judge, appropriate if either the law or the general principles were amended on the lines recommended in its reports.

The Government has since announced its decision to abolish the Commission, and a bill for that purpose has already been laid before Parliament. Nevertheless, the Commission's opinion recorded in the concluding words of its final report still stands: "We still remain of the opinion that neither we nor our successors can everywhere create effective and convenient units of local government without some amendment of local government legislation". The members of the Commission may not regret their disbanding, but while the Commission remained in being there was at least a hope that the outmoded structure of local government might be reconstructed according to some general plan, and the functional problems as well as the changes in structure which they demand would be considered. The most serious aspect of Mr. Bevan's announcement is the absence of an indication of an alternative line of approach to problems which become every year more acute and more urgent.

If the Government has thus thrown away an instrument with which these problems could have been tackled, the struggle for reform must be carried on in other arenas. The work of the Commission has already done something to bring home to a wider public a fuller realization of the problems which confront local government administration to-day. Besides Political and Economic Planning, workers at Nuffield College have also been investigating these problems. Results of such research were presented last year in a volume of "Essays in Local Government"*, edited by C. H. Wilson, and Mr. Lipman's new book is a valuable contribution to the constructive thinking which must precede any reshaping of local government. His survey brings out the way in which the requirements of a community and technical or administrative efficiency become modified with changing environment and technological progress. He demonstrates conclusively that if scientific progress expands the facilities of transport or there are radical changes in the social habits of the population, administrative areas cannot remain static but must be altered to fit the changed circumstances. Administrative areas exist to serve the purposes of local government: they are means to an end, and must be adapted to serve the ends which the local government prescribes.

Those ends must be determined by our view of the functions of local government, and Mr. Lipman is careful to refrain from prescribing solutions for particular problems. That is the function of the practical administrator, and Mr. Lipman is content to indicate the principles and the factors that have to be considered in reaching an administrative decision. He emphasizes how the evidence available upon the geographical and social structure of the population stresses the existence within the various groupings, except the industrial areas, of both urban and rural components and also of some kind of hierarchy of geographic communities, or at any rate of urban centres, with the territories they serve. These two factors favour those schemes which aim at uniting town and country rather than keeping them separate, and which envisage some type of two-tier or even multi-tier structure rather than those proposing a system of single all-purpose authorities.

Mr. Lipman further urges that the new approach to the mapping of social units suggests the possibility of a synthesis between the two principles of community and efficiency, resulting in administrative areas which would represent natural communities and yet satisfy the requirements of the local government services. He appears to accept the view that in each service there are different functions—some need a large area, others a smaller area—and that local government authorities of different grades should participate in the service at the appropriate level of function. His conclusions are put forward with great reserve and as requiring clarification in the light of a thorough survey of the geographical structure of the population, with particular reference to the relationship of urban centres to their surrounding countryside and the varying radii of influence of centres in respect of the different services they provide.

It is not, however, in deference to such fact-finding as a basis for policy that the Government has shelved the question of local government reform. The impression derived is rather one of impatience with the fact-finding of the Boundary Commission itself, and the light thrown thereby on the implications of the Government's predilection for centralization. This impression is strengthened by what is taking place in various fields that bear on local government. The importance of having local authorities both administratively efficient and vitally responsible to the local community is apparently as nothing compared with the risk that such authorities may be strong enough to resist proposals and policies convenient and desirable to the central administration, whether wise or unwise.

This question of local democracy and of units in which the individual can find effective expression lies at the root of problems of local government and of town and country planning to-day. Alike in the siting of new towns, in dealing with employment and in the planning of such areas as the congested

* Essays in Local Government. By C. H. Wilson. Pp. vii + 248. (Oxford: B. Blackwell, 1948.) 18s. net.

industrial belt stretching along the coast from north Yorkshire through County Durham up into Northumberland, it is worth while to consider the factors which have been responsible for the success of the rural community councils and those other developments in village life to which prominence is given in recent reports from the National Council of Social Service and the Carnegie Trust for the United Kingdom. The solution of problems of unemployment, the location of industry and the like, indeed, demand not deference to local or sectional prejudice but a sympathetic understanding which will lead to a synthesis enlisting the co-operation and understanding of all concerned.

Nowhere is this more apparent than in the question of national parks. Apart from the fears aroused by the attitude of the Minister of Town and Country Planning, Mr. Silkin, in the final stages of the National Parks Bill in the House of Commons on July 19, there has been fresh concern as to whether national parks are ever to be achieved in Great Britain, more particularly in view of new proposals regarding bombing ranges and the plans of the British Electricity Authority for developing hydro-electric power in North Wales. While the National Parks Bill has been improved in some respects, notably by the amendment which protects from compulsory purchase the inalienable land of the National Trust, on administration it is clear that the only effective protection of national parks rests with the Ministry of Town and Country Planning. Moreover, the Minister is not prepared to insist on joint planning boards where local authorities object to the creation of national parks; the conception of a national park is thus debased to the level which the most self-interested authority is prepared to accept.

To secure that the national interest prevail over any sectional or local interest is, of course, the fundamental reason for entrusting the local administration of national parks to bodies on which the national interest would be predominant, although it has always been recognized in the Dower and Hobhouse Reports that the full understanding and co-operation of local interests would be an indispensable factor in success. What is increasingly clear, however, is not only that the local authorities cannot be trusted—even if it is fair to expect them—to take a national rather than a local view, but also that they are unable to resist those sectional interests which represent the greatest danger to the areas designated in the Hobhouse Report as national parks.

The statement recently issued by the Council for the Preservation of Rural Wales on the hydro-electricity proposals is worth examining from this point of view. The proposals so far divulged are deplored as a whole because of the major threat to the rural beauty of Wales. The Snowdon and Nant Ffrancon schemes are to be resisted to the utmost both as affecting the magnificent scenery in localities in the heart of a national park, and the latter also from a scientific point of view, while they offer very small industrial advantage in return. Subject to over-riding conditions to be laid out in a forthcoming full report, the Council concedes that some of the schemes may be acceptable, and suggestions are made for minimizing the injury to amenity.

Protests have also been made by the president of the British Mountaineering Council as well as the Standing Committee on National Parks of the Councils for the Preservation of Rural England and Wales. It would be a national misjudgment to sacrifice to present needs and difficulties such a vital and irreplaceable element in the national wealth which Nature has built for us in North Wales. It should not be thought, however, that the British Electricity Authority is attempting to force a decision: each scheme is to be discussed with the local planning authority, and all authorities and interests concerned are to be consulted.

There is, however, an element of timing involved. If, in the near future, a North Wales national park comes into being, a joint board will be required for the whole park, and that board would be the local planning authority for most of these schemes. There is much to be said for postponing decision until the position of the national park authority is clear. Not only will friction be avoided, but also the chances of reaching a decision on the proposals as a whole and not on individual schemes will be enhanced, and with that the probability of one in which the long-term national interests and not short-term sectional interests are the determining factor.

Meanwhile, the situation emphasizes the inherent danger in the reluctance of the Minister of Town and Country Planning to insist that as a minimum each national park shall be planned as a unity under a joint planning board. Simultaneously, however, the weakness of the individual local planning authorities in the face of departmental pressure is being demonstrated in the matter of training areas for the Services. New claims for permanent training areas within the boundary of the proposed Dartmoor national park have been put forward and have been supported by the Minister of Town and Country Planning, in contravention of his own statement on March 18, 1948, after the inquiry which awarded 33,000 acres for this purpose. That award was itself regarded by many people as excessive in the heart of a national park, and the Devon County Council is making a firm stand about the new claims. Some slight reassurance may in the meantime be found in the announcement of the Secretary of State for Air that he is reconsidering the whole matter of the re-opening of the bombing range on Frampton Sands. This site is close to the remarkable sanctuary for wildfowl which, since the War, the Severn Wildfowl Trust, generously helped by the Pilgrim Trust, has done so much to develop, and the proposal has been the subject of wide and authoritative protest.

Any satisfaction at this announcement must be tempered by the realization that it is the Government's own failure to formulate a proper procedure, and its persistence in piecemeal procedure, which are responsible for this endless series of disputes and the perpetual threat to the twin ideas of national parks and Nature reserves. Mr. Silkin is fast dispelling all confidence in his willingness or ability to act as arbiter in conflicting departmental claims; but with the

best will in the world, he could not be effective while in even a single matter, such as land for the Services, the Minister of Defence makes no effort to co-ordinate demands and permits demands to be advanced in isolation. All that has transpired since the National Parks Bill was first introduced demonstrates that the first condition for an effective system of national parks and Nature reserves in Britain is an interdepartmental committee at Cabinet level competent to balance conflicting claims on a national and not a sectional basis. It is equally clear that the planning and administration of each individual park or reserve must be the responsibility of a body qualified and trusted to take a national and not a sectional or local view, and to have regard to long-term interests and not to the immediate exigencies or difficulties.

ELECTRONIC CIRCUITS

Electronic Time Measurements

Edited by Prof. Britton Chance, Robert I. Hulsizer, Edward F. MacNichol, Jr., and Prof. Frederick C. Williams. (Massachusetts Institute of Technology, Radiation Laboratory Series, No. 20.) Pp. xviii+538. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 42*s*.

Cathode Ray Tube Displays

Edited by Prof. Theodore Soller, Prof. Merle A. Starr and Prof. George E. Valley, Jr. (Massachusetts Institute of Technology, Radiation Laboratory Series, No. 22.) Pp. xvii+746. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 60*s*.

Components Handbook

Edited by John F. Blackburn. (Massachusetts Institute of Technology, Radiation Laboratory Series, No. 17.) Pp. xvii+626. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 48*s*.

THE three volumes under review represent a further contribution to the series issued by the Massachusetts Institute of Technology to give a full account of the work carried out by the Radiation Laboratory in the development of radar during the War. A number of these volumes have now been issued, and the present three form worthy members of the series.

The first of these volumes, "Electronic Time Measurements", is really a sequel to Volume 19, "Waveforms", and describes some very ingenious circuit developments originated both in Great Britain and in the United States. Prof. F. C. Williams, well known for his original work on circuits at the Telecommunications Research Establishment in Britain during the War, contributes to the volume, particularly in a most interesting section on electronic integrators.

The very precise measurement of time intervals formed one of the key problems in precision radar and in the accurate navigational systems such as 'Gee' and 'Oboe' which were developed from radar technique. The circuits developed for such measurements are fully discussed and also such problems as those of automatic following of radar responses and smoothing of information for feeding to computers in order to obtain gun-laying information, etc. The volume includes a description of the very elaborate system developed in the United States for relaying the plan position indicator (P.P.I.) picture as seen in an aircraft to a station on the ground and also a discussion of the problems of permanent echo cancellation using supersonic delay lines. Along with Volume 19 it gives a comprehensive picture of the many and ingenious 'video' circuits developed for radar and is well worthy of study by all circuits engineers.

The second volume in this group, "Cathode Ray Tube Displays", gives a very comprehensive treatment of the principles of operation of the cathode ray tube and of its use to display radar and other information in a great variety of forms. As a means of display the use of the cathode ray tube was universal in radar practice, and a great variety of new types of display were developed. Both in cathode ray tube design and in use, British and American practice in this case did not differ to any great extent.

The volume starts with a discussion of the fundamental principles of the cathode ray tube, including electron deflexion and focusing. Then follows a discussion of the special display problems which arose as radar developed. How these problems were solved is shown in the description of a large number of special types of display. Perhaps the most interesting of these is the plan position indicator which enables a radar map to be presented on the cathode ray tube. The problem of synchronizing the rotating time-base with the aerial rotation to provide this display is fully dealt with. As the range and complexity of radar equipments increased, it became impossible for a single operator to absorb all the information available on a single P.P.I. display. A discussion of the difficult problem of breaking this up into a number of sectional displays and showing each on a separate cathode ray tube forms an interesting chapter.

Although most of the displays discussed were developed for radar applications, the design data will be of considerable use to workers in other fields who wish to use cathode ray tube displays. The scan and focusing circuits used for different types of tube are fully discussed and the relative advantages of magnetic and electrostatic deflexion and focusing described in some detail.

An interesting chapter on screen materials is included. This goes into the physics of luminescent materials, particularly as related to long afterglow screens. The volume forms perhaps the most comprehensive treatment of the cathode ray tube and its use available so far, and will be of great value to all who wish to use this most powerful tool as a means of display.

The third volume in this group, "Components Handbook", gives a survey of many of the components used in the construction of radar equipment, particularly at the Radiation Laboratory. Although an attempt has been made in most volumes of this series to include some description of British practice, in this case very little is said about British components. This is scarcely surprising, as the task of including even all the more important components developed specially for radar at the Radiation Laboratory is itself a formidable one, and drastic selection has had to be made. The most interesting part of the book consists of a description of these new types of component. These include delay lines, both electromagnetic and supersonic, phase shifting and 'sweep-scanning' condensers, various types of repeater, torque amplifier, etc., known as synchro systems. The development of such instruments for

use in triangle solvers, resolvers, etc., is fully discussed and makes a very interesting study.

A considerable part of the volume is set aside for the description of the more pedestrian components, such as inductors, capacitors and resistors. The search for stable resistors is of interest. The same difficulties were clearly met as were all too familiar in Great Britain. Undoubtedly the weakest part of most radar equipment lay in the components themselves, and a very large percentage of failures were component failures. That a great advance in design of radio components was needed and was achieved will be abundantly clear from the contents of this volume. This advance has, however, gone ahead even more rapidly since the volume was written, and much of the subject-matter is now of historic interest only. The development of new materials such as high-K-ceramics, silicones and low-loss dielectrics, together with new techniques for wiring, and for rendering equipment impervious to attack by moisture, etc., makes much of the technique described obsolescent. This applies to the present volume probably more than to any other in the series. There is, however, much of permanent value, and the design engineer will find the book very useful for reference for a long time, particularly in giving data on American practice.

R. A. SMITH

METALLURGY FOR ENGINEERS

Engineering Metallurgy

By W. E. Woodward. Pp. x+176. (London: Constable and Co., Ltd., 1948.) 15*s*. net.

MR. WOODWARD'S book is an attempt to compress a large field of metallurgy in a small compass, and consequently a detailed treatment cannot be expected. The book consists of 176 pages and deals with the manufacture, treatment and properties of ferrous and non-ferrous alloys.

A student of engineering appreciates a short concise book in any of his subsidiary subjects, and he relies on the accuracy and clarity of statement. Unfortunately, Mr. Woodward's book contains many statements which are incorrect. On p. 13, a peritectic reaction is described as a "transformation occurring at a constant temperature during the heating or cooling of an alloy in which two phases react to form a single new phase". On p. 14, it is stated that "Changes take place in the solid, the most common being the breakdown of a solid solution into its component parts in precisely the same manner that a liquid freezes with the formation of a eutectic". According to the first statement, the transformation of pearlite to austenite is a peritectic, and according to the second, the decomposition of the β-phase of a tin bronze results in a mixture of copper and tin.

Under the heading "The Iron–Iron carbide constitution diagram" the A_1 point is described, and it is stated that "the temperature of transformation falls as the carbon content decreases". This is not true. Tables of properties of heat-treated steels are given to "give as clear a picture as possible of the effect of carbon alone and carbon together with heat treatment". For example, carbon steels containing 0·335, 0·53, 0·74 and 0·95 per cent carbon, water-quenched from above the Ac_2 point, gave ultimate stress values of 99·5, 69·5, 30·3 and 20·4 tons/sq. in. respectively, and Vickers pyramid numbers of 618, 862, 876 and 912 respectively. The 0·335 per cent carbon gave 1 per cent elongation and the others a zero extension. These figures are not representative.

Statements such as "Sulphur exists in carbon steels as FeS which melts at rolling and forging temperatures", or "Phosphorus exists in carbon steels as Fe_3P, which like FeS has a lower melting point than the steel itself", are, to say the least, misleading. Similar types of statements occur in the non-ferrous section. For example, "Like other very ductile and malleable metals, copper has a body centred lattice".

I have mentioned only a few of the misleading statements, and although I can follow Mr. Woodward's train of thought, the book is written for a student who cannot be expected to sort things out for himself. In its present form, the book contains many aspects which are relatively unimportant to the engineer, and it would be better to narrow the scope rather than to attempt to incorporate the whole of metallurgy in so sketchy a fashion.

A. J. MACDOUGALL

PROGRESS IN PHYSIOLOGY

Annual Review of Physiology

Edited by Victor E. Hall, Jefferson M. Crismon and Arthur C. Giese. Vol. 11. Pp. x+643. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1949.) 6 dollars.

AT the beginning of its second decade this publication finds itself firmly established as an essential constituent of any library related to physiological study. The editorial committee is to be congratulated on its achievement in face of all the difficulties of these past ten years.

Recognizing the rapid increase in the quantity of published material and also the appearance of several new reviews covering fields which overlap sections of physiology, the editorial committee has adapted the present volume in two ways. First, the editors of sections have been encouraged to select the most noteworthy contributions in their particular fields, and secondly, these sections have been confined more nearly "to the domain of classical physiology" by the omission of chapters on special aspects of the subject.

The effects of this policy are very evident in this volume. The chapters or section move from the condition of a mere catalogue to one expressing a point of view. While this change makes for ease of reading, it will require careful regulation lest the publications become a collection of 'special reviews' rather than an annual review of the subject. The other effect is the disappearance of separate sections on applied physiology. This does not mean the omission of all reference to work of an applied character, but rather the distribution of such references to the appropriate section of the subject.

When examined from the above points of view, Volume 11 is a very satisfactory volume. The sections are mainly devoted to the publications of 1947 and 1948. They are clearly written and, in the several sections tested by the writer of this review, are very complete. In view of the editorial policy, there are striking omissions, but no doubt these will be filled in the process of editorial rotation. Volume 11 is some ninety pages longer than its predecessor, and for domestic reasons two of the promised chapters on "Heat and Cold" and "Cutaneous Sensation" have been omitted.

A Direct Entry to Organic Chemistry

By Prof. John Read. (Home Study Books, No. 6.) Pp. xiii+268. (London: Methuen and Co., Ltd., 1948.) 4*s*. 6*d*. net.

THE schoolboy's well-known observation that "Read's books are so readable" is most surely applicable here if anywhere. This self-contained little book will appeal alike to the intelligent layman and also to those who wish to begin the study of organic chemistry and are in search of a general survey of the subject before embarking upon the standard text-books. Indeed, the title "A Direct Entry to Organic Chemistry" is very apt, as the book leads one quickly, easily and with the minimum of preliminaries right into the subject. Conventional fundamental ideas about atoms, molecules, electrovalent and covalent linkages, and isomerism are dealt with clearly and simply. Subjects discussed from an attractive descriptive angle include fats, carbohydrates, proteins and coal-tar products; and brief simple references are made to such topics as penicillin and chemotherapy. Quite apart from any information which the general reader may readily pick up from the book, it is also obvious that Prof. Read has interwoven in its pages something of the philosophy and spirit of chemistry which have made some of his earlier historical sketches so much alive. It is fitting that the book should have been the subject of the award of the "Premio Europeo Cortina Prize" of a million lire (£500) given by the Italian journal *Ulisse* for the best recently published popular scientific work.

B. C. SAUNDERS

Un naturaliste en Cote d'Ivoire

Par Renaud Paulian. (Les livres de nature, 74.) Pp. 217. (Paris: Éditions Stock, 1949.) 270 francs.

THIS small book gives in a semi-popular style an account of the animal and, to a less degree, plant life in a tropical West African forest region. It is mainly concerned with the forest reserve of Banco, some 8 km. from Abidjan in the French Colony of the Ivory Coast. Much of the forest is secondary; but some more or less primary forest was visited. It is stated that forest reconstituted in place of secondary forest has a fauna comparable to that of a true primary forest but that floristically the constitution remains different. A majority of pages are devoted to insects, and the chapters on ants and termites are particularly interesting. Studies of organisms in a tree canopy were made by means of observation posts established up to 37 m. in a tree of *Parinarium tenuifolium*. The nocturnal life of organisms in the forest canopy proved as regular as diurnal life. The book is illustrated by forty-seven clear text figures, mostly of animals and plants, but has no index.

W. B. T.

Les fondements de la géographie humaine

Par Prof. Max Sorre. Tome 2: Les fondements techniques, Première partie: Les techniques de la vie sociale, les techniques et la géographie de l'énergie, la conquête de l'espace. Pp. 608. (Paris: Armand Colin, 1948.) 1100 francs.

UNFORTUNATELY, only half of this work on social geography by Prof. Max Sorre, of the Sorbonne, has yet appeared, and the text now before us is not necessarily fully representative of the whole. The first volume was "Les Fondements biologiques"; of the second volume the work now before us forms Part 1, but Part 2, "Les Techniques de Production", has not yet been published, while Vol. 3, "L'Habitat", has also yet to appear. The third volume will concentrate most closely on the factor of environment and is thus likely to be the most useful contribution of all to the geographer.

The work is very ambitious, and indeed, from the study of Vol. 2, Part 1 alone, it is doubtful if the reviewer has had access to a sufficient proportion of the entire work to pass a fair verdict on its range and quality. This difficulty is the more obvious because of the minuteness of the detail by which Prof. Sorre illustrates his argument in a survey of the evolution of transportation and of the routes of commerce; for it is on the subject of the evolving geography of routes that Sorre is here primarily concerned. Such a subject holds a nuclear position in "la géographie humaine" which, the reviewer believes, should preferably be translated into English as 'social' not 'human' geography. Sorre's debt to the inspiration derived from Vidal de la Blache, the founder of the most distinguished French school of geographical philosophy, is recognized on almost every page and not only in the extensive bibliography.

W. FITZGERALD

Population Analysis

By T. Lynn Smith. (McGraw-Hill Publications in Sociology.) Pp. xiii+421. (New York and London: McGraw-Hill Book Co., Inc., 1948.) 27*s*.

POPULATION analysis, in any serious sense, is here confined to the United States, for which is made the proud claim of leadership in demographic studies. Virtual restriction of inquiry to the United States in respect of density of population, composition by racial origins, fertility, mortality, migration, etc., treated in successive chapters, is at once observed by the range of the many cartograms—reminiscent of the excellent illustrations in the U.S.A. Census Reports—and, quite frankly, the author writes with an American audience in mind. Although this is suggested in the preface, it might have appeared also in the title, now too comprehensive. Probably to American undergraduates the geographical limitation will not seem important, though for purposes of balance and perspective it seems urgent to the reviewer that particularly the younger students of population in the modern world should learn to avoid too parochial an outlook and too little attention to the eastern hemisphere, where the greater part of the population of the world resides.

W. FITZGERALD

British Herbs

By Florence Ranson. (Pelican Books, A.183.) Pp. 203+16 plates. (Harmondsworth: Penguin Books, Ltd., 1949.) 1*s*. 6*d*.

THIS little book contains an account of British herbs and their uses, with useful information on their history, hints on herb gathering and drying, commercial herb growing and marketing. The plants are arranged alphabetically by their common names, followed by a chapter on the herb garden, dealing with the aspect of such a garden, its cultivation and arrangement. The book is well illustrated by line drawings and several excellent photographs. A list of books for further study and an index of common names is provided, but it seems a pity that the botanical names of the plants dealt with were not included in the index. There is much in this volume to attract the attention of those interested in herbs, and it forms a useful addition to the well-known series of Pelican books.

H. S. M.

CHEMISTRY AND THE FOOD SUPPLY

THE important and ever-increasing part played by chemicals in modern agriculture was the subject of a number of papers presented on September 6 to Section B (Chemistry) at the Newcastle meeting of the British Association.

Dr. G. I. Higson, in introducing the subject, said that to provide everyone in the world with an adequate diet would mean doubling the present food supply, which is a formidable if not impossible task. Additional food must come from agriculture, and the provision of increased quantities of fertilizer by chemical industry is still the most important aid that chemistry can give to agriculture. At present only some three per cent of the world food production can be attributed to use of nitrogenous fertilizers. To raise the available food by ten per cent, that is to say, one hundred million tons, involves a four-fold increase in supplies of fixed nitrogen, at an approximate capital cost of £1,500,000,000. This would require fifty million tons of coal or its equivalent annually, and would take a minimum of fifteen years to achieve. Changes can be expected in the form of nitrogenous fertilizer used, as world sulphur supplies are not inexhaustible, and urea may prove to be a convenient material.

Increasing supplies of fixed nitrogen require to be balanced by phosphate and potash, and the known mineral reserves appear to be adequate for more than two hundred years, while other deposits no doubt exist. Shortage of sulphur may necessitate changes in present techniques for converting phosphates into a form available to plants, but the use of nitric acid or of electric furnace methods are possible alternatives. The rate of expansion of the synthetic nitrogen industry will be determined by the rate at which the agriculturists can be persuaded to increase their usage of nitrogenous fertilizers in order to meet the ever-growing demand for extra food.

Dr. E. M. Crowther, in dealing with the effect of chemicals on crop growth, referred to the spectacular changes in fertilizer manufacture since 1843, when J. B. Lawes first advertised his so-called 'patent manures'. Fertilizers are still mainly used in industrial countries, and there are large areas of peasant farming where they are not yet used. Rapid developments in fertilizer practice for arable crops played a vital part in enhancing war-time food production. In the ten years from 1938, the consumption of fertilizer nitrogen in Great Britain rose from 60,000 to 190,000 tons of elemental nitrogen, the corresponding increases for phosphorus and potassium being 70,000 to 160,000 and 60,000 to 150,000 tons, respectively. The efficient use of available fertilizers is an essential factor in food production, and to this end field experiments to determine crop responses and optimum fertilizer applications have been in progress for more than a hundred years. To-day there is an urgent need for the application of more fertilizer to our grasslands.

Utilization by crops of the plant nutrients added in fertilizers is relatively poor, especially of phosphate. Band placement is notably effective in improving the efficiency of phosphate and potassium fertilizers; but at present this method is of limited application only, and considerable further research is required. Variations in fertilizer practice often appear to have arisen due to historical or geographical accidents. Thus the British water-solubility test for available phosphate has strongly influenced the form of mixed fertilizers in Britain, whereas American development of ammonium nitrate and anhydrous ammonia as fertilizers has arisen partly because the synthetic ammonia works lack a convenient source of sulphate. New developments are continually occurring; nitric acid may partially replace sulphuric as a means of breaking down the apatites in mineral phosphate, while urea–formaldehyde products are showing promise as substitutes for some of the organic wastes which liberate ammonia slowly in the soil.

Recent developments in the field of selective weed-killers were described by Mr. S. W. Cheveley. Weed control was formerly effected by using chemicals such as cyanamide or sulphuric acid, which acted because of physical differences between crop and weeds. In 1940 Templeman observed that one of the simpler plant-growth regulators, α-naphthyl acetic acid, killed a weed like yellow charlock without harm to the corn crop. A search for cheaper chemicals soon led to the discovery of 2 methyl-4-chlorophenoxy acetic acid ('Methoxone') and 2.4 dichlorophenoxy acetic acid (2.4.D). Great activity followed in this field, but the mode of action of these 'hormone' weed-killers is still not clearly understood. 'Methoxone' has been shown to interfere with the potassium metabolism of susceptible plants, but this is thought to be not the whole story. These new types of selective weed-killer are relatively slow in action, and considerable care has to be taken to apply them at the right time and under the right weather conditions. A recent addition to the range, 2.4.5-trichloro-phenoxyacetic acid, has shown promise against brambles, scrub bush and similar weeds.

No other chemical innovation has had such wide and rapid acceptance in agriculture. To-day, more than ten per cent of the total cereal crop of Great Britain is being treated, while in the United States in 1949 the products were used on eighteen million acres. Good control of weeds can be obtained for an expenditure of 25–45 shillings per acre, while average increases of crop yields of 20–25 per cent are obtained, representing a cash return of £4–5 per acre for the grain alone. Great benefits should be obtainable by the use of these new weed-killers on grassland, a technique already practised in Holland. Weed control is not suggested as preferable to ploughing and re-seeding, but its use in conjunction with lime, fertilizers and drainage could greatly increase the productivity of much semi-derelict grassland. There is still very much to be learnt about selective weed-killers, but in them agriculture has a remarkable new instrument of great promise in helping to increase crop yields on both arable and grassland.

Mr. D. D. Ogilvie, in surveying recent chemical contributions to the improvement of animal health, stated that although major acute epidemic diseases are now generally under control, the more chronic and debilitating diseases are still on the increase. Losses in Britain are estimated at more than £50,000,000 per year, about half of which is due to four diseases of dairy cattle alone. The reduction of these losses and their elimination, if possible, depends largely on the improved use of chemical methods.

Internal parasites are probably the greatest present source of trouble. The discovery in America some

ten years ago of the anthelmintic properties of thiodiphenylamine (phenothiazine) has made it possible to effect control of worm infestations, and the use of repeated small doses has shown promise as a means of eventual extermination of the pest by interfering with egg-laying by the female worms, and rendering the eggs laid non-viable in the fæces. The use of carbon tetrachloride or hexachlorethane is an efficient method against liver fluke, a pest responsible in Britain for annual losses of some 1,500 tons of animal liver. The new insecticides such as D.D.T. and benzene hexachloride permit effective control of most external parasites, though against warble fly derris or rotenone are still the best remedies.

Bovine mastitis, which is responsible for very great losses of milk, is a typical example of a bacterial infection against which chemotherapy has been strikingly effective. Thus modern techniques involving the use of sulphonamides and penicillin have made possible the elimination of mastitis from individual herds in as short a time as one or two weeks. Conspicuous successes have been claimed by chemical agents in the attack on protozoan infections which are especially important in tropical and sub-tropical areas. Thus coccidiosis can be effectively controlled with sulphadimethylpyrimidine, while the recent discovery of 'Antrycide' holds out hope that the menace of trypanosomiasis may ultimately be overcome. However, practical application of known remedies lags far behind, especially in the case of the insidious disorders which are sapping the strength of the livestock population of the world, and it is urgent that more attention be devoted to increasing the use of existing control methods.

Mr. L. W. L. Cole surveyed the use of chemicals in control of insects, the depredations of which can nullify the labours of millions of farm workers. Losses in the United States have been estimated at 1,200 million dollars during the decade 1930–40. In view of the world food position these losses are intolerable, and recent developments in chemical insecticides reveal possibilities of control undreamt of ten years ago. The production of a number of new materials, such as D.D.T., benzene hexachloride, chlordan, parathion, etc., effective in very small concentrations against a wide variety of insects, has altered the picture. The ever-increasing annual tonnage of insecticides has led to questions as to their possible effect on human health; but the use of poisonous materials is controlled by legislation, and their commercial application is delayed until adequate tests have been completed.

The relation between chemical structure and biological activity is still unsolved, and, though great advances have been made and many theories proposed, it is not yet possible to synthesize specific insecticides for a particular purpose. Most of the new insecticides exhibit a degree of specificity, but there is always a danger that they may kill other predacious and parasitic insects which assist in control of some other pest. As regards methods of application, automatic machines are now in use which can apply large volumes of spray to orchards in a fraction of the time formerly taken, while the use of various petroleum oils as carriers permits the effective dispersion of an insecticide using rates of only two to ten gallons per acre. The use of aircraft for application of insecticides is expected to develop rapidly in the near future.

There are still cases where the insect holds its own, such as the tsetse fly in Africa (though some success with D.D.T. has recently been reported), the Mediterranean fruit fly and the leaf-cutting ants of South America. New chemicals and new methods of use are, however, continually under trial. The application of chemicals to the soil which, after absorption by the plant, make it poisonous to the insects, presents great possibilities, especially in the case of crops such as cotton and flax, while this method affords a prospect of controlling plant virus diseases carried by insects.

In the last paper of the series, Dr. H. S. Hirst dealt with the use of chemicals in the preservation as silage of green forage crops, a method of growing importance in providing winter food for cattle. The mechanism of the reactions occurring in the silo is far from clear, but little fundamental research on this subject appears to be in progress either in Great Britain or in the United States. Efficient preservation depends on the rapid reduction of the *p*H of the silo contents to about *p*H 4, where detrimental enzyme and bacterial action ceases. When fermentative production of lactic acid is relied on, molasses is often added to ensure the presence of adequate fermentable sugar, and American workers recommend the addition of from two to three times the amount normally used in Britain. The A.I.V. process involving direct addition of mineral acid is widely used in Scandinavia, but has not been generally adopted in the United States or Britain on account of practical difficulties. The effect of initial moisture content on the efficiency of preservation has led to the development in the United States of a method whereby the crop is allowed to wilt in the field to a moisture content of 65–70 per cent before ensiling. None of the methods available is, however, consistent and foolproof. The average losses in Britain in silage making are probably of the order of 20–25 per cent of the dry matter of the fresh crop. A target of about 2·5 million tons of silage has been proposed for Britain, and reduction of present losses to half would, on this amount of silage, save foodstuffs of an approximate value of £500,000 per year, a figure which justifies considerable attention being paid to this problem.

MEASUREMENT AND TREND OF INTELLIGENCE

A SYMPOSIUM on "Psychological Studies of the Quality of the Population" was held by Section J (Psychology) at the Newcastle meeting of the British Association, with the president of the Section, Sir Godfrey Thomson, in the chair. Prof. P. E. Vernon (London), introducing the subject, outlined the well-known facts of the differential birth-rate not only between different social classes but also between families of different intelligence-level within the same class. Most authorities agree that this should lead to a decline of 1½ or more points of average intelligence quotient per generation, and that the numbers of very bright children may be halved, of feeble-minded children doubled, before the end of the century. The only direct evidence of such a decline in the national intelligence is that obtained by Burt in his successive standardizations of versions of the Binet scale, and this may have been upset by migration of many brighter families or by incomplete representativeness of the samples he tested. Similarly, the reported rise

in numbers of mental defectives between 1907 and 1929 is largely attributable to more complete ascertainment.

Intelligence as measured by present-day tests is by no means wholly a genetic quality, though most competent workers agree that nature contributes two to three times as much to its variance as nurture. The evidence from parent–child resemblance, from twin studies, and investigations of foster children was surveyed by Prof. Vernon, but regarded as inconclusive. The results claimed by Wellman, Skeels, Schmidt and certain other American psychologists point to greater modifiability of intelligence by upbringing than has often been supposed in the past, but certainly do not justify their virtual repudiation of any hereditary determination. Factorial analysis reveals that tests measure verbal and other abilities besides *g* (Spearman's general factor). Moreover, group tests are susceptible to practice and other influences which might entirely outweigh any small decline brought about by genetic changes. Prof. Vernon refused to accept the view that intelligence is an innate quality and that it is merely our tests which are at fault; he preferred to define it operationally as the highest common factor—the *g*—that can be extracted from test results, and urged the need for further investigation with tests which give purer measures of *g* and are less subject to practice effects.

Prof. L. S. Penrose (London) considered that intelligence is an unsuitable quality for genetical study because, in practice, most people fail to distinguish between some vague and hypothetical property of the individual and test scores. Moreover, different tests often measure different things. He stated that no decline due to differential fertility has been, or is likely to be, found. The Wood report figures on the increase of mental defectives are valueless for this purpose; they show a far higher incidence among school children than among infants or adults. Clearly the standards adopted in ascertainment are quite unreliable. Several sets of inter-parental and inter-sib, and parent–child correlations in intelligence were quoted. These do not, as is usually believed, fit the theory of additive genes, since the close correlation to be expected from assortative mating is usually neglected. In spite of differential fertility, a stable distribution of intelligence in the population might be maintained through the operation of heterosis, since the least intelligent members of the population are infertile. The important condition for stability is that individuals at the bottom as well as at the top should have few children, and the fact that dull individuals have large numbers of sibs is irrelevant. Any slight residual tendency to decline might easily be surpassed by quite small environmental changes. Thus, although both height and longevity are negatively correlated with size of family, it is well known that the population is getting taller, not shorter, and is living longer.

Mr. J. Maxwell (Edinburgh) and Mr. D. Kennedy Fraser (Glasgow) described briefly the procedures used in the 1932 and 1947 Scottish mental surveys. In the latter (an account of which may be found in the recently published "The Trend of Scottish Intelligence"), more than seventy thousand children, representing almost the entire eleven-year age group, was given the same group intelligence test as in 1932. Also a sample of twelve hundred was tested individually with the Terman–Merrill revision of the Binet scale. Instead of a decline over the period of fifteen years a significant rise occurred, particularly among girls, on the group test. This could, however, be attributed largely to increasing familiarity of children with group tests, since there was no appreciable rise in education areas which make very little use of tests and a still larger increase in areas where similar tests are thoroughly familiar. Moreover, when the individual test results were compared, by statistical techniques devised by Dr. J. A. Fraser Roberts, no appreciable rise or fall was found in either sex.

At the same time the negative correlation between intelligence and family size was strongly confirmed. It persisted both among children with very young, and with relatively old, mothers; and it persisted within separate occupational groups. For example, there was the same drop of 1½ points in score (roughly equivalent to 1½ intelligence quotient points) for each extra child in the professional group as in the whole sample. No consistent relation could be discovered between position in family and intelligence score. All these findings argue against an environmentalist explanation of the trend. Detailed sociological schedules, including parental occupation, age of mother, etc., were collected by health visitors and district nurses for a sample of about seven thousand children; and much further information of psychological, sociological and educational interest should emerge when there has been time to analyse it more fully.

Finally, some points of interest about the tests deserve mention. Girls were appreciably superior to boys on the group test, and there were much larger numbers of very dull boys. On the other hand, boys were more than three intelligence quotient points superior to girls on the Terman–Merrill scale. The latter showed a much wider spread of intelligence quotients than has usually been assumed, namely, a standard deviation of twenty points, and the distribution was positively skewed, there being many more children (at this age) with very high than with very low quotients.

NEW DEVELOPMENTS IN INTERFEROMETRY

IN Section A (Mathematics and Physics) of the British Association at the recent meeting at Newcastle upon Tyne, three papers covering somewhat contrasting aspects of modern interferometry were presented at a session held on September 6. With reference to the shearing interferometer, discussed below, opportunities were provided to see its application to testing a 30-in. telescope mirror at the optical works of Sir Howard Grubb, Parsons and Co.

Dr. T. A. Littlefield (King's College, Newcastle) reviewed the development of the reflecting echelon and its application not only to precision wave-length measurements, but also to hyperfine structure investigations in line spectra. Although Michelson in 1898 had considered using the echelon grating as a reflecting instrument, the accumulated errors of an optically contacted pile of glass plates in 'staircase' formation rendered the original instruments unsuitable except for use in transmitted light. Williams in 1929 found that plates of quartz and fused silica, particularly the latter, could be contacted without appreciable irregularity and distortion, and later produced, in conjunction with the firm of Adam Hilger, the first successful reflecting echelons. They required,

nevertheless, an extremely high quality of optical workmanship—as, for example, equality of step thickness to about $\lambda/80$ in visible light—to achieve the resolving limit ($d\nu$) of 0·018 cm.$^{-1}$ theoretically attainable with an echelon of forty plates each 7 mm. thick.

Outlines were given of the optical principles underlying the process of fringe formation with the reflecting echelon and the experimental arrangements for associating its dispersion with that of a normal spectrograph. Among the advantages claimed for the echelon are permanence of adjustment and high intensity, combined with range and uniformity of performance. Because the echelon is used in a sealed chamber, wave-length comparisons can be undertaken *in vacuo*, thus eliminating the effects of atmospheric refraction and dispersion. The disadvantages are an occasional difficulty, with a single echelon, in resolving uncertainties of interference orders in hyperfine structure, and the so-called 'envelope' effect. As the instrumental conditions are normally adjusted for observation of two fringe orders, this effect tends to displace the intensity maximum of each fringe towards the centre of the diffraction pattern due to the rectangular step faces.

Referring to the work on interference spectroscopy at Newcastle, Dr. Littlefield said that two reflecting echelons are available, one of which is on loan from the Royal Society. The programme includes precise determinations of secondary wave-length standards in the visible and ultra-violet spectra of argon and krypton; preliminary measurements on krypton lines have already been published[1]. Another interesting item is the measurement of isotopic mass displacement effect in krypton lines, using pure single isotopes of even mass number electromagnetically isolated from the natural gas by Dr. J. Koch at the University Institute for Theoretical Physics, Copenhagen. With the echelon it is expected that wave-length differences between the corresponding structureless radiations of separate isotopes may be detected to an accuracy of 0·0001–0·0002 A. in the visible region. To improve the precision of intensity measurements in hyperfine structure, a photocell is to be used with the Jackson combination of echelon and prism. The envelope effect will be eliminated by placing the photocell slit at the centre of the diffraction envelope and sweeping the fringe pattern over the slit by varying the air pressure in the echelon chamber.

Dr. W. J. Bates (H. H. Wills Physical Laboratory, Bristol) discussed methods of two-beam interferometry in which identical wave-fronts are displaced laterally or rotated with respect to one another. The development of these optical processes, described as wave-front shearing, originated from considerations of the basic optical principles involved in the precision testing of large telescope mirrors. The usual comparison interferometric methods utilize a substantially error-free wave-front as a reference standard, which is produced either by a mirror similar to that under test or by an equivalent lens-mirror system. For various reasons these provisions are often quite impracticable. Independent comparison standards are, however, unnecessary if one wave-front from the mirror under test is first divided into two parts which, upon recombination, are relatively displaced or sheared either laterally or by rotation about a principal ray passing through the observer. The wave-front is, in fact, compared with a 'sheared sight of itself'.

The optical theory and practice of wave-front shearing interferometers[2] were outlined. The arrangement of components in one form of the instrument is similar to that of the Mach–Zehnder interferometer as applied in aerodynamical investigations of the flow over aerofoil surfaces in wind tunnels. An important difference, however, is that no shear is used in the latter interferometer, whereas the former, if adjusted to zero shear, may be applied to the same purpose, and is easier to construct and adjust.

Reference was made by Dr. Bates to some interesting tests applied with the shearing interferometer to a parabolic mirror of 74-in. aperture now installed in the Radcliffe Observatory at Pretoria. In the final stages of figuring, it was known from knife-edge and Ronchi tests that zonal errors were present. The interferometer was used, with a slit source illuminated by a high-pressure mercury arc, to assess these errors, and thus furthered the successful correction of the mirror. The accuracy attainable in determining figuring errors is estimated to be about $\lambda/30$.

These experiments have led to the design and construction of an inverting interferometer in which rotatory shear, as defined above, is used for more comprehensive tests, including those for astigmatic errors. With this instrument it is also possible to employ the image of a high-pressure mercury arc as an extended source, thus providing ample light for projecting the interference fringes on to a screen.

An application of the shearing interferometer to interference microscopy was also mentioned. It would sometimes be advantageous in the phase-contrast microscope if the phase difference between the direct and diffracted beams could be continuously varied to suit the object viewed. This has been achieved with an interferometer associated with a microscope condenser and objective, but the phase shifting can be more elegantly accomplished with a specially designed miniature interferometer incorporated in an eyepiece unit of normal dimensions.

Mr. H. Barrell (National Physical Laboratory) presented an account of the interferometric techniques and light sources used for precision length measurements in terms of light waves[3]. With special discharge lamps containing a single isotope of mercury or krypton of even mass number as emitter, the purity of the radiations is so high that interference phenomena become observable over a path difference of 50 cm. or greater. There is an increasing tendency to utilize interferometry for calibrating the reference end-standards of length. The modern form of steel end-standard or block gauge, as used in precision engineering workshops to control linear dimensions, has proved well adapted for the purpose owing to the optical perfection of its hardened working surfaces.

After demonstrating the strong molecular cohesional forces developed when two or more flat-ended steel gauges were 'wrung' together or brought thus into optical contact with a flat glass surface, Mr. Barrell described two gauge interferometers. In the Kösters instrument, the optical scheme is based on the Twyman–Green modification of the Michelson interferometer. A reflecting combination, formed by wringing the gauge to a flat base-plate of steel, acts as one of the mirrors. The other interferometer, of National Physical Laboratory design, employs the Fizeau principle and can deal with twenty gauges in one measuring operation. It is therefore well adapted to routine work on batches of slip or block gauges comprising sizes from 5 cm. (2 in.) downwards, whereas the German instrument, accepting one gauge

only at a time, is better suited to measuring larger sizes.

Both instruments incorporate a monochromator, so that the fringe patterns can be observed in different radiations from a suitable source. The same technique of fringe observation is used, and the calculation of length is reduced to a simple procedure based on Benoit's method of exact fractions and the use of a Kösters wave-length slide-rule. Accurate measurement of gauge temperature is essential. Corrections are applied for departures of the gauge temperature and the ambient atmospheric conditions from the accepted standards, as well as for any dissimilarity of phase loss suffered by light reflected from the gauge and the base-plate surfaces.

Commonly used light-sources are the cadmium and the krypton discharge lamps of heated-cathode type manufactured by the General Electric Co. When the krypton lamp is cooled in liquid air to reduce Doppler effect, lengths up to 30 cm. (12 in.) are measured in the Kösters instrument to an accuracy of $\pm$ 0·025 μ (10^{-6} in.), a figure which represents the average precision attained with both interferometers throughout their respective ranges of measurement.

Experimental work is proceeding in co-operation with the General Electric Co. on the development of discharge lamps for krypton-84, isolated by Dr. Koch as mentioned earlier, and for mercury-198 obtained from gold after irradiation with neutrons in a nuclear reactor. Several Fabry–Perot interferograms were exhibited which demonstrated the superiority of radiations from mercury-198 over those from naturally occurring cadmium and mercury. The fundamental importance of such sources in metrology and spectroscopy lies in the immediate prospect presented of establishing a wave-length of light as the ultimate length standard, and thus realizing an idea as old as the British Association itself. H. BARRELL

[1] Littlefield, T. A., *Proc. Roy. Soc.*, **A, 187**, 220 (1946).
[2] Bates, W. J., *Proc. Phys. Soc.*, **59**, 940 (1947).
[3] Barrell, H., *Research*, **1**, 533 (1948).

THE SCIENTIFIC DEPARTMENT OF THE NATIONAL GALLERY

By F. I. G. RAWLINS and A. E. A. WERNER

LIKE many British ventures, the Scientific Department of the National Gallery started in a small way. Even to-day it has no pretences to size, but it has probably grown up sufficiently to fulfil its purpose and to help, as experience shows it does, by advice over a wide field. In 1934 the board of trustees decided that a physics laboratory should be set up to collaborate with the art-historical staff in providing objective data concerning the methods used by the great masters, and to study picture structure and questions of atmospheric environment. At first there was little contact with problems of conservation. That, as the sequel shows, was to come a full decade later.

In early days it became manifest that the whole position would be strengthened if an advisory committee of distinguished men of science, interested in paintings, could be appointed to keep in touch with the laboratory and to act as a link between it and the board of trustees on one hand and outside institutions on the other. This was done (the trustees nominating the members), and the committee has rendered, and is rendering, a great service to the national collection. Meetings are held quarterly, when reports are received and discussed.

During the Second World War, with the pictures in exile at Manod Quarry, North Wales[1], the task of the Scientific Department became one of dealing with the numerous difficulties, most of them entirely new, associated with underground storage on a considerable scale, and the erection and working of an air-conditioning plant. That the task was accomplished may perhaps best be judged by the fact that up to 1939 the equivalent of eight months a year was spent in minor repairs to pictures (for example, laying blisters, closing cracks, adjusting stretchers, and so forth). The first year at Manod required about a fortnight's work: this progressively diminished until, in 1945, the visit of the appropriate officer was purely formal: there was nothing to be done. A scientifically controlled environment had provided striking results. The return to London, however, provided a different story: the behaviour of the pictures, both panels and canvases, was alarming. There was an epidemic of flaking and blistering (due to the relatively rigorous climate of Trafalgar Square), the great frost of 1946–47 adding further to the Gallery's troubles. The need to harness all available scientific knowledge to help in the work of conservation of the collection has resulted in the establishment of a chemical laboratory (1948), and the extension of the physics section to include a wider choice of controls. Close association with the Department of Scientific and Industrial Research is a feature of the Department, and at all stages, before, during and after the War, much assistance has been most willingly given by the Ministry of Works.

Physics Laboratory

Partly by accident and partly by design, the physics section has tended to specialize in X-radiography and colorimetry. In addition, a fair amount of microscopy and physical optics is involved. All this is because it was soon seen that such processes represent a refined form of non-destructive testing applicable to basic needs and *ad hoc* problems alike. Broadly, in this laboratory we are concerned with the picture itself, not with its components, and thus, apart from work on 'models', we are more or less restricted to what radiations of various wave-lengths can tell us, both about condition and about picture-structure as such.

As might be expected, the prime essential is a knowledge of the anatomy of paintings: without this information, physical research is largely sterile. Support, ground, paint-film, surface-film, form a sequence of layers having close and complex relations with each other; moreover, the whole assemblage is in general strongly anisotropic, both minutely and in bulk. The support—usually wood or canvas—can be conceived as a biological substance of fairly normal character. Upon it are superposed the other layers, all more or less of the species 'paint', differing from each other in pigment-vehicle ratio and purpose more than in physical nature. These facts suggest forcibly a likeness to geological formations; a typical stratified system with planes of weakness, slip, distortion, together with the presence of interfacial tensions, occluded gases and so on. In addition are forces of erosion and abrasion, not to mention intrusion and extrusion. Such a conformation invites investigation by petrological technique. That, in fact, is very

largely the method in use. Wood itself has long been known to be approximately orthorhombic in symmetry, an observation of which use may be made in dealing with structural defects. Reactions to the intake and output of moisture from and to the atmospheric environment of a picture cause much trouble with panel paintings, and rational means of dealing with them depend in the last resort upon an appreciation of the elastic coefficients of an orthorhombic gel. Picture canvases usually shrink when dry and expand when wet (the opposite of the normal textile), on account of the hygroscopicity of the sizing overpowering the natural behaviour of the fibres.

From these considerations it will be seen that any information which physics can supply about structure, both general and local, is likely to be valuable both to conservators of paintings and to historians. The latter not infrequently desire objective evidence of certain types of build-up assumed to be characteristic of certain schools and masters. In such cases, of course, pictures in perfect condition and of undisputed authenticity are presented to the laboratory for examination. Concerning the means employed to achieve these ends, perhaps the most effective are X-rays and infra-red radiation. The National Gallery is exceptionally well equipped in both these respects. Reduction of penetration in working with the former is essential if refined contrast between neighbouring areas of paint is to be obtained. Thus, for some years past soft rays from a tube working at 20 kV. have been used, whereas quite recently experiments have begun with a Machlett tube with beryllium window, permitting results to be obtained at 6 kV. Numerous initial difficulties are being experienced; nevertheless considerable promise is detected of ability to achieve selective differentiation hitherto unknown in such work. Other developments are contemplated.

The advantage of infra-red photography is that one is not presented with a picture composed of a number of superposed images, such as is normally the case with radiography. Thus, interpretation is apt to be simplified. Success depends, of course, upon the relative transmission and reflexion coefficients of the various layers: in favourable cases it is possible to reveal much of the condition of the paint-film behind a thick discoloured layer of varnish. Obviously this is a matter of importance to the restorer, especially in the early stages of his work. Ultra-violet light is also of importance in revealing the presence of repaint, and places where surface films have perished, in both instances by characteristic fluorescence. Viewed diagnostically, it is usually possible to obtain a very complete guide to the physical condition of a picture by means of X-rays, the ultra-violet and the infra-red.

Experience has shown that simple methods of colorimetry such as use of the Lovibond tintometer, and especially the Rothamsted improved instrument, can give much interesting information by comparison of a picture before and after cleaning. This method has been in use as a matter of routine for some years past, and the opportunity now afforded of being able to give results in international units seems likely to increase its usefulness many times. A kindred problem is that of gloss, especially in relation to the search for ideal surface coatings, which must possess acceptable optical properties, in addition to satisfying certain mechanical and chemical needs. In all these tasks the physical laboratory is busily engaged.

Chemical Laboratory

The decision of the board of trustees to set up a chemical laboratory was, to a certain extent, prompted by the recent controversy over the cleaning of pictures at the National Gallery[2]. The establishment of such a laboratory and the appointment of a research chemist were practical steps taken to increase the objective 'fact-finding' potential of the Scientific Department as a whole. The wisdom of this decision was endorsed by the report of the Weaver Committee[3], which regarded it as a move in the right direction towards implementing certain of its recommendations. The chemical laboratory has been furnished and equipped in the most modern manner; in view of the many supply difficulties besetting a project of the type at the present time, a word of congratulation is due to the officers of the Ministry of Works responsible for the efficient manner in which the work was carried out, and the high quality of the workmanship.

The scope of work and the nature of the problems under investigation in the chemical laboratory vary widely. Hence, for the sake of convenience, they will be discussed under three separate headings, namely, (*a*) routine work, (*b*) investigation of *ad hoc* problems arising from the immediate demands of the Restoration Department, and (*c*) fundamental long-term research concerned chiefly with obtaining more precise information about many of the materials used by the old masters.

(*a*) The routine work involves, first of all, the supervision and testing of all chemicals—particularly organic solvents—used in the restoration studios, to ensure that they are up to the requisite degree of purity. Furthermore, there is the routine examination of paint specimens to determine the chemical nature of the pigments present. As well as using the classical microscopic tests, the Feigl 'spot-test' technique, using modern organic reagents for metals, is being developed with success; this technique is not only easier to carry out, but also the degree of sensitivity is in many cases greater. Information about the stratified structure of a painting is frequently of paramount importance to the restorer, and the technique of mounting cross-sections of paint specimens for microscopic examination is being tried out on a series of worthless canvases obtained for the purpose.

(*b*) In the past many of the techniques evolved as the result of empirical experimentation by restorers have been to a large extent dictated by the choice of that particular natural material the sum of the properties of which was most suitable for the job in hand. It inevitably followed that certain methods of treatment necessitated a compromise and consequent departure from the ideal method, which must be visualized as involving the absolute minimum of risk to the painting undergoing treatment. In an attempt to remedy this state of affairs, it is appropriate to inquire to what extent these traditional materials may with advantage be replaced by newer materials, particularly those of the synthetic high-polymer type, thus evolving a simpler and probably safer method of treatment. A close analogy is supplied by natural rubber which, on account of its unusual combination of properties, was used for many purposes for which it was not ideally suited; it has now been superseded in many instances by synthetic elastomers.

In illustration of this principle, the following *ad hoc* problems, which are at the moment under active investigation, may be considered. The traditional

adhesives—glue and the Plenderleith wax–resin mixture—although excellent in most respects, both suffer from the inherent disadvantage that their mode of application requires the use of heat. Hence an investigation is being carried out on the possible use of modern cold-setting adhesives, both of the high-polymer solvent type and the chemically setting urea and resorcinol–formaldehyde types. Similarly, the traditional materials used as protective surface coatings, namely, mastic or dammar resins dissolved in a suitable solvent, become in the course of time discoloured and brittle. Consequently a search for an improved surface-coating free from these disadvantages is being made among the synthetic film-forming materials; particular attention is being given to polybutylmethacrylate, which seems most promising because it gives a surface coating having an æsthetically pleasing appearance. As already mentioned, one of the most urgent problems awaiting a satisfactory solution is the provision of a suitable material, which may be applied to the backs of pictures to act as a moisture barrier, thus reducing those dimensional changes caused in supports by the intake and output of moisture due to variations in relative humidity. This item of research is being carried out with the collaboration of the Forest Products Research Laboratory at Princes Risborough. The actual materials under investigation include natural products such as waxes, and synthetics such as 'Saran' (polyvinylidene chloride) and polythene film.

The examples chosen so far have all dealt with those aspects of the general problem of picture conservation which are less appreciated by the general public, who are more conversant with the 'cleaning' process, that is, the actual removal of such accretions as dirt, discoloured varnish and possibly later repaints. There are many factors which govern the choice of solvent (or solvent mixture) to be used in the actual cleaning process, but the ideal solvent must be one which shows the maximum solvent differential between the varnish layer and the original paint layer, and yet is sufficiently active to remove the varnish layer without an undue amount of friction. In order to obtain more precise data, a systematic investigation is being conducted upon the degree and speed of swelling of aged linoxyn films by various solvents.

(c) The activities of the chemical laboratory have up to the present been so taken up with *ad hoc* problems that it has not yet been possible to progress beyond the formative stage, so far as fundamental research is concerned. One can but indicate the trend of such work by a brief reference to two problems which are of outstanding interest in this field. Although we know a very great deal about the various pigments used by the old masters, precise knowledge about the actual nature of the media used is sadly lacking. This state of affairs is primarily due to the absence of suitably precise methods of analysis; such information as we have at present is derived from simple qualitative solubility tests. It is hoped to develop the technique of partition chromatography to obtain precise information concerning the nature of the media—whether tempera, oil or oil–resin—used by the old masters. Secondly, information is also required about the composition of many of the resins, the use of which is recorded in certain of the old recipes. Any increase of our knowledge in these two fields would be of interest, not only to the scientific investigator but also to the art-historian; it might serve to narrow the gap that separates art and science.

Important as all its primary functions are, the Scientific Department of the National Gallery does not overlook the philosophical and methodological aspects of an objective approach to cultural matters. For the whole range of museum activities such an outlook is clearly significant.

[1] Rawlins, F. I. G., *Nature*, **151**, 123 (1943).
[2] Plenderleith, H. J., *Nature*, **160**, 523 (1947).
[3] Constable, W. G., *Nature*, **162**, 166 (1948).

OBITUARIES

Mr. A. H. Hall, C.B., C.B.E.

Mr. Arthur Henry Hall died at his home at Farnham, Surrey, on September 10, at the age of seventy-three. Mr. Hall, the son of H. S. Hall, was born at Clifton in 1876 and was educated at Clifton and at Trinity Hall, Cambridge, where he took a first in the Mechanical Science Tripos. On leaving Cambridge in 1898, he entered the famous firm of cross-Channel shipbuilders, Messrs. W. Denny Bros., of Dumbarton, and left them in 1905 to join the Ordnance Department of the War Office. The following year he became assistant mechanical engineer at the Royal Arsenal, Woolwich, and in 1914 he transferred to the Royal Small Arms Factory, Enfield. On the outbreak of the First World War he returned as assistant superintendent to Woolwich, where he remained until 1917. He joined the Admiralty staff in 1917 and for two years was director of torpedo and mine production. He was then lent to the Ministry of Munitions and later became controller of ferrous and non-ferrous metals and chemical disposals.

In 1926 Mr. Hall joined the Air Ministry to take charge of airship construction work at Cardington, and two years later he followed the late Mr. Sydney Smith as chief superintendent of the Royal Aircraft Establishment, Farnborough, a position he held until his retirement at the age of sixty-five in 1941.

The years 1928–41 were among the most eventful in the history of the Establishment, and indeed of aviation. At the beginning of this period the Royal Air Force was still very much a junior Service, civil aviation was struggling to its feet, and Great Britain was going through one of the worst economic blizzards the world has known. Although the future of aviation was in no doubt, few realized its importance to the country, and still fewer realized the vital part research and development were to play during these years and the war years that were to follow. To maintain our position in aviation meant conserving and carefully directing the small amount of effort available, and at the same time building up the knowledge and the essential resources on which the future would depend.

This was the task facing Mr. Hall when he took over at Farnborough in 1928; he quickly set about reorganising the shops and design offices, and was successful in getting rid of a large number of the temporary buildings that had sprung up ten to fifteen years before. At the same time, the opening of the seaplane tank in 1933 and the 24-ft. wind tunnel in 1935, and the start of the Bygrave building and the high-speed tunnel in 1939, are indications that the need for new equipment and laboratory buildings was

fully appreciated. During these years, and under Mr. Hall's leadership, the Establishment not only grew in size but also won the confidence of the aircraft industry and the Services, and its reputation as a centre for aeronautical research and development became world-wide.

In recognition of his services, Mr. Hall was created C.B.E. in 1918 and C.B. in 1937. He was a member of the Institution of Mechanical Engineers, a fellow of the Royal Aeronautical Society, and during the years 1928–41 he served as a member of the Aeronautical Research Committee.

He had a wide and, indeed, intimate knowledge of large numbers of his staff, was a keen observer of men, and his judgment of individuals was seldom wrong. It was fitting, therefore, on his retirement in 1941, that he was retained as a consultant by the Ministry of Aircraft Production, and played a large part in recruiting the technical and scientific staffs required by the various Ministries.

Mr. Hall was a man of very wide interests; he loved fishing, was an enthusiastic bird-watcher, and a very active gardener. He was also a keen photographer. For many years he had interested himself in educational matters, and had been chairman of the board of governors of the Farnborough Grammar School since 1937, and was a member of the Aldershot and Farnborough Divisional Education Executive.

Mr. Hall's death will come as a shock to the large circle who came to know him through his work, and those who were privileged to know him well will realize they have lost one of the most likeable and staunchest of friends. W. G. A. PERRING

Prof. W. B. Morton

WILLIAM BLAIR MORTON died in Belfast on August 12 at the age of eighty-one. He was born in Belfast, and went to school at the Belfast Royal Academy. After matriculating in 1886 into Queen's College, Belfast, then associated with the Royal University of Ireland, he took the B.A. degree with honours in mathematics in 1889 and proceeded to St. John's College, Cambridge, where he became eighth wrangler in the Mathematical Tripos of 1892. He had intended to stay in Cambridge for research, but was asked by Everett to return to Belfast as his assistant in the Department of Natural Philosophy. He accepted the invitation and succeeded to the chair in 1897, occupying it until he retired on reaching the age limit in 1933, with a change in title to professor of physics in 1909 after Queen's College had become the Queen's University of Belfast.

Morton was above all an inspiring teacher. He undertook personally the greater part of the undergraduate lecturing in both mathematical and experimental physics, besides giving postgraduate courses on theoretical subjects and much appreciated public lectures. In spite of the demand this made on his time, he read widely in the history of science and in current mathematical and physical literature, and published some forty papers, mostly on the theory of electricity and hydrodynamics. His staff were usually left to develop their own lines of research, in which they received every encouragement, not least through the generosity with which he made available his large private library. His departmental duties left him little time to take part in the general administration of the University. After his retirement, however, he rendered great services as a member of the governing body and its main committees.

An appointment as a junior fellow of the Royal University of Ireland in 1894 had been followed by a fellowship in 1897, which was continued until the dissolution of the Royal University in 1909. The connexion with colleagues in the south of Ireland was maintained after the institution of the National University of Ireland by frequent appointments until 1934 as external examiner. The visits these necessitated to Dublin, Cork, Galway and Maynooth were a source of great pleasure to him.

After the death of his wife in 1945, Morton moved from the house in which they had lived for forty years and made a long succession of colleagues and students welcome at their informal week-end gatherings. He broke up his library at the same time, giving the greater part to the Queen's University, and most of the remainder to friends. Failing health gradually restricted his activities, but until a few months before his death he continued to visit the University regularly, and to take an interest in its affairs. K. G. EMELEUS

NEWS and VIEWS

Prof. Frank Debenham, O.B.E.

PROF. FRANK DEBENHAM, who has just retired from the chair of geography at Cambridge which he was the first to hold, is a descendant of an old Suffolk family. He took his first degree at Sydney, and it was as geologist, cartographer and surveyor that he went with Scott to the Antarctic. Of him it may truly be said that he has done a great work in keeping alive the magnificent exploratory and scientific ideals with which Scott and his colleagues and contemporaries faced the grim Ross Barrier in 1910; ideals which have indeed proved an inspiration to the succeeding generations. Thirty years have passed since Debenham was elected to a fellowship of Caius College, Cambridge, fresh from the war service which followed immediately his return from the Antarctic. Tripos examinations in geography were first held in 1920, and he was soon busy in the new Department. In 1928 he succeeded the late Philip Lake as reader and head, in the year when the International Congress of Geography met at Cambridge. His vigorous creative powers found full scope; and by 1930, in the year of his appointment to the newly-established chair, he was planning the erection of the new building, to which his cherished project of a physiographical laboratory was added in 1938. The Cambridge school, to which Prof. J. A. Steers has just succeeded (see *Nature*, April 10, p. 670), may now fairly claim to have attained an international reputation; and its productivity, characteristic liveliness and happy diversity of aims undoubtedly owe much to the brisk exploratory activities and the very human sympathies of its first professor.

As teacher and expositor, Prof. Debenham's enthusiasm was infectious; and his writings reveal a much appreciated facility and clarity of expression. His recent surveys of African water problems for the Colonial Office, still in progress, have with his other work been recognized by awards of the Victoria Medal of the Royal Geographical Society, and the Livingstone Medal of the American Geographical Society; he has also received the honorary D.Sc. of

the University of Western Australia. In addition, the Scott Polar Research Institute at Cambridge remains as a continuing memorial not merely to his own efforts as founder-director, but also to a tradition of exploratory determination, painstaking survey and scientific inquiry which he has himself upheld. Like that earlier explorer Cadmus, he too can espy as a geographer *tot natas natosque et pignora cara nepotes*. Prof. Debenham will be assured of the affectionate regard and esteem of a great number of colleagues, friends and past students, who will wish him many happy journeys with Mrs. Debenham, who has shared so much in his Cambridge adventure.

Military College of Science, Shrivenham: Sir Reginald Stradling, C.B., F.R.S.

SIR REGINALD STRADLING, whose appointment as dean of the Military College of Science, Shrivenham, has been announced, is notable for his work in applying science to the problems of the building industry. He was trained as an engineer and, after the interruption of the First World War, during which he served in the Royal Engineers and gained the M.C., he became a lecturer in civil engineering at the University of Birmingham, and then head of the Building Department at Bradford Technical College. In 1924 he became director of the then young Building Research Station of the Department of Scientific and Industrial Research, and remained there up to the start of the Second World War. Under his control the Station developed rapidly and won recognition from the traditional industry which it was created to serve. In 1939 he undertook the duties of chief adviser on research and experiment to the Air Raid Precautions Department of the Home Office, which afterwards became the Ministry of Home Security. As this organisation developed under the stress of war, he built up a considerable scientific staff to investigate the problems of civil defence. Here again much pioneer work had to be done, and some of the methods of investigation which were developed were ultimately used with excellent effect in building up the Allied offensive. In 1944 he became chief scientific adviser to the Ministry of Works, where he was responsible for bringing the results of research to bear on problems of post-war building, and particularly on non-traditional house construction. In addition, he organised research into sociological and economic problems of building which were not being investigated elsewhere. Unfortunately, a breakdown in health early this year made it necessary for Sir Reginald to transfer his activities to a less arduous post, which his half-time appointment at Shrivenham should prove to be. His many friends will be delighted to know that he is now able to return to work in a position in which his knowledge and experience will still be available to the public service, while he himself will be able to continue working in his chosen fields of research.

Photographic Plates for Nuclear Research: Dr. R. W. Berriman

DR. R. W. BERRIMAN, of the Kodak Research Laboratories, Wealdstone, Harrow, Middlesex, has recently received the following telegram. "In the name of those participating in the International Congress on Cosmic Radiation at Como we wish to send you our great appreciation of the important contribution you have made to the development of the photographic method of detecting charged particles. Amsterdam, J. Clay; Berkeley, R. B. Brode; Bristol, C. F. Powell; Brussels, Occhialini; Chicago, Marcel Schein; London, G. P. Thomson; Manchester, P. M. S. Blackett; New York, J. J. Rabi; Paris, Leprince-Ringuet, P. Cuer; Rome, G. Bernardini; Zurich, P. Scherrer." Dr. Berriman has been closely concerned with the development of the Kodak *NT4* plate, a photographic plate which is widely used for research in cosmic radiation and which is capable of detecting any known charged particle (see *Nature*, **161**, 432 (1948); **162**, 992 (1948)).

Premio Europeo Cortina Prize: Prof. John Read, F.R.S.

PROF. JOHN READ, professor of chemistry and director of the Chemistry Research Laboratory in the University of St. Andrews, has been awarded the Premio Europeo Cortina Prize of 1,000,000 lire (£500) for his book "A Direct Entry to Organic Chemistry" (see p. 596 of this issue). It was judged to be the best popular scientific work published in any language during the past four years. This year the award was made for books on physics and chemistry only. Thirty-five entries, including British, Italian, French, Portuguese, Dutch and Spanish, were made for the Prize, which is offered by the city of Cortina in conjunction with the Italian journal *Ulisse*. The British entries were considered outstanding, and the final choice lay between Prof. Read and Prof. O. R. Frisch of Trinity College, Cambridge. The award was made to Prof. Read, and Prof. Frisch's book, "Meet the Atoms", was highly commended.

A Professional Association for Statisticians

THE rapid spread of the use of statistical methods in science, industry, commerce and administration in the last decade has created a new professional class of statisticians. The Royal Statistical Society itself has been alive to this development and has done much to promote a recognition of the status of the statistician in the Civil Service and in business; but by tradition and constitution it is primarily a learned Society, and there has been growing evidence of a desire among practising statisticians for a professional body similar to the existing Associations of Actuaries, Accountants and Secretaries. A newly formed Association of Incorporated Statisticians, limited by guarantee, is intended to meet this need. The objects of the Association are to provide professional qualifications for statisticians, to encourage the provision of training facilities and to further and protect the interests of its members. Membership is divided into two classes, fellowship and associateship, and there is also to be a class of registered statistical assistants with privileges of membership other than voting rights. Normally, admission to fellowship or associateship is to be by examination, coupled with evidence of substantial experience of statistical work; certain exemptions are to be permitted where persons already possess qualifications and experience, but the object is to limit such exceptions so as to make membership of the Association evidence of a proper standard of competence. The syllabus of the examinations of the Association, which are to be in two stages, intermediate and final, are very similar to those laid down by the Royal Statistical Society for the award of its certificate and diploma, but there is rather more emphasis on statistical administration; for example, one paper in the final examination is on "the organisation and equipment of a statistical department". The president of the Council of the Association is Lord Beveridge and the vice-president is Dr. Bernard

Dudding. The honorary secretary is Mr. S. Harris, and the registered office is at 54 New Broad Street, London, E.C.2.

Atomic Scientists Association

THE July issue of *Atomic Scientists News* is notable in that for the first time the journal is bound in an attractive coloured cover, a considerable improvement in appearance. The contents of the issue include a report of the annual general meeting, held on June 25, of the Atomic Scientists Association, and a survey by a Birmingham study group of the problem of atomic weapons and civil defence. At the annual meeting the following officers were elected: *President*, Prof. R. E. Peierls; *Executive Vice-President*, Dr. K. Lonsdale; *Honorary General Secretary*, Dr. F. C. Champion; *Honorary Treasurer*, Dr. T. G. Pickavance; *Editor of the News*, Dr. J. L. Michiels; *Librarian*, Dr. W. D. Allen. Because of a reserve of £1,600, largely built up from profits made on the sale of the guide to the "Atom Train", the financial position of the Association was considered sound, though an annual deficit of some £300 is being incurred owing to the considerable secretarial expense and the cost of maintenance of the London office of the Association.

The president in his report referred to some of the problems which had occupied the attention of the Council, in particular, the likely consequences of an atomic attack on Great Britain and the steps that could be taken to minimize them; measures taken against Communists and other persons associated with extremist political organisations in the Civil Service; and misleading press reports on atomic energy problems. The report of the Birmingham study group is interesting. Rescue work, radiation dangers, fire-fighting and the efficiency of shelters are discussed. The two main conclusions arrived at are: first, that in an atom bomb attack on a town in Great Britain the number of casualties would be so large that if only a small fraction of these could be prevented or rescued, many lives would be saved; and second, that there would be less chance of learning from experience than there was in the Second World War, and thus the air-raid precautions organisation, including the necessary public propaganda, must be complete before the event of the first raid.

Research Council for the Linoleum Industry

THE linoleum and felt-base floor-covering industry has set up a Research Council with the approval and support of the Department of Scientific and Industrial Research. Linoleum manufacture offers wide scope for research, the endowment of which will form the initial policy of the Council. Problems include the oxidation of the basic raw material, linseed oil, its processing and compounding and calendering on to hessian backing, and also the manufacture and development of the special paints used for linoleum. Arrangements have already been made with the Paint Research Station for work on some of the problems of drying oils, linseed oil, gels and sealing coats for saturated felts. An information service has been set up, a central library started and a survey of patents relating to the industry begun. Dr. S. R. W. Martin has been appointed superintendent of research, and a programme of fundamental research has been agreed. The secretary is Mr. A. G. Vaughan. The membership of the Research Council includes substantially the whole industry, and the headquarters are at Roxburghe House, 273-287 Regent Street, London, W.1.

British Trust for Social Studies

THE purpose of the British Trust for Social Studies is to encourage social research of scientific and practical importance by making small grants, not less than £20, for particular projects to persons, other than full-time research workers, who have the opportunity for social observation and wish to record their impressions and work up the material in their own spare time. The recipient of a grant will be expected to produce within an agreed period a paper of 5,000-7,000 words setting out the results of the research in a way that can be understood by intelligent non-technical readers. The papers so produced will be at the disposition of the Trust for publication. Application forms and further information can be obtained, by post only, from Miss Marion Nuttall, Secretary, British Trust for Social Studies, 16 Queen Anne's Gate, London, S.W.1.

Announcements

THE Managers of the Royal Institution have accepted with regret the resignation of Prof. E. K. Rideal, whose duties will terminate on December 31, 1949. Prof. E. N. da C. Andrade, Quain professor of physics in the University of London, has accepted an invitation to become director of the Royal Institution, resident professor and director of the Davy Faraday Research Laboratory. He will assume his duties on January 1, 1950.

PROF. K. MATHER, professor of genetics in the University of Birmingham, Prof. S. Zuckerman, professor of anatomy and physiology in the University of Birmingham and chairman of the Panel on Imports Substitution, and Prof. G. F. Marrian, professor of chemistry in relation to medicine in the University of Edinburgh, have been appointed members of the Agricultural Research Council in succession to Prof. T. G. B. Osborn, Sir John Simonsen and Mr. W. J. Wright, whose terms of office have expired.

PROF. J. D. BERNAL will speak on "Science in the U.S.S.R. To-day" at the Beaver Hall, Mansion House, London, E.C.4, on October 15 at 2.30 p.m. The lecture has been arranged by the Science Section of the Society for Cultural Relations with the U.S.S.R., 14 Kensington Square, London, W.8, from which tickets are available.

THE Museum of the History of Science, Old Ashmolean Building, Oxford, which began in 1924 as the Lewis Evans Collection, is to be re-opened by the Earl of Crawford and Balcarres on October 11 at 2.30 p.m.

BIOLOGISTS everywhere will learn with regret that the laboratories of Flatters and Garnett, Ltd., of Manchester, were seriously damaged by fire on the night of September 17–18. The firm's entire stock of some thirty to forty thousand microscopical preparations was destroyed, as well as much valuable equipment. The Skeleton and Dissection Department has also suffered severely, and much preserved botanical material has been lost. The bulk of the firm's lantern slide negatives has been saved, although the stock of finished slides has been destroyed. The Chemical Department and Instrument Works are unaffected, and the office and warehouse at 309 Oxford Road, Manchester 13, are functioning. Messrs. Flatters and Garnett state that work on the rebuilding of the burnt-out portion has already commenced, and temporary accommodation has been found for the departments affected.

SOME ASPECTS OF BONE MARROW METABOLISM

By Dr. C. LUTWAK-MANN
Biochemical Laboratory, University of Cambridge

OWING to its inaccessibility and the relatively small amount present in the body, bone marrow until recently has received less attention from the biochemist than is warranted by its great biological significance, which has been established on the basis of hæmatological studies. The object of this investigation was to accumulate facts concerning certain important cell constituents of bone marrow in the hope that this would contribute towards a better understanding of bone marrow metabolism, and that the information gained would open up a possibility of a quantitative assessment of bone marrow activity under normal and pathological conditions.

Young adult rats and rabbits served as experimental animals; the bone marrow was obtained from the long bones (femur, tibia, humerus). The analytical results below are given in mgm. per 100 gm. fresh weight.

Distribution and breakdown of phosphorus compounds in bone marrow. Results obtained with four sets of litter-mate rabbits belonging to different breeds are given in Table 1, from which it can be seen that whereas there are considerable variations in the concentration of the phosphorus compounds between the litters, there is fairly good agreement between litter-mates. As regards acid-soluble phosphate, the fluctuations in the level of inorganic phosphate may be partly due to phosphatase activity of bone marrow referred to later. There is more readily-hydrolysable phosphate than corresponds to adenylpyrophosphate, suggesting the presence of yet another acid-labile phosphate ester[1]. The variations in the actual level of adenylpyrophosphate in fresh bone marrow may be partly, but not entirely, due to enzymic breakdown, because although rabbit bone marrow is capable of decomposing it by dephosphorylation and deamination, these enzymes are not very strong, and the presence of preformed adenylpyrophosphate could be demonstrated in bone marrow suspensions after several hours incubation, especially under aerobic conditions.

Lipid phosphorus varied little from one set of litter-mates to another, but the differences in nucleic acid phosphorus were considerable. As the content of nucleic acid presumably depends upon the cellularity of the bone marrow, these values are a good indicator of the metabolic potential of the tissue. Corroboration of this assumption was derived from experiments in which glycolysis and respiration were determined parallel with nucleic acid phosphorus; bone marrow, where the level of nucleic acid phosphorus was high, showed invariably much more vigorous metabolic activity than samples where its content was low.

Table 1. Phosphate distribution in rabbit bone marrow

Rabbit litter		P in mgm. per 100 gm. fresh weight bone marrow						
		Inorganic	Readily hydrolysable	Adenylpyrophosphate		Total acid-soluble	Lipid	Nucleic acid
				pyro-P	NH_3-N			
I	1	7·80	4·90	2·48	0·56	43·00	—	113·00
	2	4·60	9·00	3·01	0·68	48·00	—	123·00
	3	5·90	7·80	4·87	1·10	40·00	—	98·00
	4	6·00	8·20	4·34	0·98	41·00	—	120·00
II	1	4·50	11·00	6·64	1·50	32·00	27·00	57·00
	2	4·00	7·50	5·23	1·18	33·00	32·00	62·00
	3	3·80	10·00	4·34	0·98	35·00	30·00	60·00
III	1	5·20	7·60	3·18	0·72	37·00	30·00	72·00
	2	8·30	11·00	3·99	0·90	36·00	36·00	79·00
IV	1	6·20	3·60	1·68	0·38	38·00	37·00	88·00
	2	7·30	5·00	1·99	0·45	40·00	34·00	91·00

In rat bone marrow total acid-soluble phosphate was 80–90 mgm. per cent, compared with 30–48 mgm. per cent in rabbit. Nucleic acid phosphorus was also much higher than in rabbit bone marrow. A distinct sex difference was established in the content of nucleic acid phosphorus in rat bone marrow, as seen in Table 2; vitamin B deficiency considerably lowered the level of this phosphorus fraction, but castration, either itself or followed by prolonged treatment with testosterone propionate, or progesterone, affected these values to a small extent.

Table 2. Nucleic acid phosphorus in rat bone marrow

Rats	P in mgm. per 100 gm. fresh weight bone marrow					
	♂	♀	♂ castrates	♂ castrates + testosterone	♂ castrates + progesterone	♂, B-deficient
Hooded	260–300	220–260	250–270	260–280		140–190
Albino	240, 260		218, 220		230, 240	

With hooded rats, highest and lowest values were based on groups of 10–20 animals; with albino rats two animals were used for each experiment.

When suspensions of rabbit bone marrow were incubated at 24° for four hours, the inorganic phosphate rose considerably, particularly under anaerobic conditions, at the expense of difficultly hydrolysable phosphate esters; under such experimental conditions total acid-soluble phosphate remained unchanged, and there was no breakdown of nucleic acid phosphorus. On the other hand, incubation of rat bone marrow for one hour at 38° produced a significant fall in nucleic acid phosphorus, which was not affected by $M/50$ fluoride. Both rabbit and rat bone marrow dephosphorylated readily various added phosphate esters concerned with glycolysis.

Ammonia formation. Incubation of bone marrow in saline, water or phosphate caused the accumulation of considerable amounts of ammonia. After 2–4 hours at room temperature, 3–5 mgm. per cent ammonia was found in rabbit bone marrow; aliquot samples examined simultaneously for their content of adenylpyrophosphate showed sometimes as much as a half to a third of it still present. In any event, the quantities of ammonia produced far exceeded those which could have been derived from total deamination of adenylpyrophosphate in rabbit bone marrow (Table 1).

In rat bone marrow incubated for 1–2 hours at 38°, 30–40 mgm. per cent ammonia was found. Parallel with bone marrow, samples of whole blood of rats and rabbits were incubated, but the amounts in bone marrow considerably exceeded ammonia produced in blood. Ammonia formation in bone marrow was not dependent upon oxygen, and it was not inhibited by fluoride, iodoacetate or toluene.

Other enzymes. In addition to enzymes capable of readily converting glucose, fructose and mannose,

but not glycogen or galactose, to lactic acid, bone marrow showed carbonic anhydrase, choline esterase and methylglyoxylase activity. The presence of deaminases in bone marrow was reported earlier[1].

Various metabolites in bone marrow. Rabbit bone marrow contained 50–100 mgm. per cent glycogen; total reducing sugar was 25–33 mgm. per cent, of which 2–4 mgm. per cent was true glucose as determined by means of glucose oxidase (notatin). Fructose was absent. Rabbit bone marrow contained 0·5 mgm. per gm. glutathione and 0·08 mgm. per gm. ascorbic acid. Citric acid was 3·5 mgm. per cent in rabbit, and 5 mgm. per cent in rat bone marrow (rat long bones contained 320 mgm. per cent citric acid). Non-protein nitrogen in rabbit bone marrow was 75–100 mgm. per cent, polypeptide nitrogen 8·5 mgm. per cent, amide nitrogen 75–100 mgm. per cent; 2·7–3·0 mgm. per cent amide nitrogen was in the protein-free filtrate.

Metals. Copper, zinc and iron were estimated in rabbit bone marrow. The copper content varied from 0·126 to 0·3 mgm. per cent, and exceeded amounts in rabbit blood. Zinc was 1·37 mgm. per cent. Iron in bone marrow was estimated simultaneously with the hæmatin content; it was found that a considerable proportion of rabbit bone marrow iron, sometimes as much as two-thirds, was non-hæmatin iron.

Effect of various agents upon bone marrow metabolism. (*a*) *In vitro.* The effect of the following substances in *M*/200 to *M*/400 concentration upon the anaerobic glycolysis of rat and rabbit bone marrow was investigated: fluoride, iodoacetate, mustard gas, mustard sulphoxide and sulphone, urethane, dimethyldithiocarbamate, amidopyrine, nitrobenzene, sulphanilamide, hydroquinone. Fluoride and iodoacetate, also mustard gas (confirming earlier work by Needham, Cohen and Barrett[2]) and mustard sulphone, but not mustard sulphoxide, all inhibited bone marrow glycolysis. Of the other substances, only amidopyrine had an inhibitory effect, especially in rat bone marrow.

(*b*) *In vivo.* The mode of application, dose and systemic effects of mustard gas, sulphoxide and sulphone in rats and rabbits and their action upon bone marrow glycolysis were reported earlier[3]. Table 3 shows the characteristic changes in acid-soluble and nucleic acid phosphorus in rat bone marrow following treatment with mustard gas and mustard sulphoxide, the latter alone and together with dimethyldithiocarbamate (dimethyldithiocarbamate was introduced into mustard gas studies by G. R. Cameron and H. N. Rydon; Porton Report, 1944). The remarkable 'mustard gas-like' action of very small amounts of sulphoxide in combination with dimethyldithiocarbamate, in contrast to the relative inactivity of either of these substances alone, was demonstrated before[3], but no study of phosphate distribution was made at that time. Dimethyldithiocarbamate could be replaced in such experiments by diethyldithiocarbamate, but not by ethylcarbamate (urethane).

No striking effects upon bone marrow glycolysis or nucleic acid phosphorus were observed following prolonged administration to rats of lead salts, sulphasuxidine, urethane or amidopyrine.

The adverse effect of total body exposure to X-rays upon bone marrow metabolism was described recently[4]. On the other hand, direct *in vitro* irradiation of bone marrow with 20,000 r. had no effect upon glycolysis or nucleic acid phosphorus.

Table 3. Effect of mustard gas and mustard sulphoxide upon acid-soluble and nucleic acid phosphorus in rat bone marrow

Treatment	Days after treatment	P in mgm. per 100 gm. fresh weight bone marrow	
		Total acid-soluble P	Nucleic acid P
Untreated control	0	88	287
Mustard gas, 0·1 ml. 4% solution in ethylene glycol ether, cutaneous application	2	55*	58*
	4	111	200
	6	94	240
	8	78	235
Mustard sulphoxide, 0·01 mgm./gm., subcutaneous injection	2	79	247
	4	80	240
	6	90	260
Mustard sulphoxide, 0·01 mgm./gm., plus dimethyldithiocarbamate, 0·1 mgm./gm., subcutaneous injection	2	58*	88*
	4	113	240
	6	120	224
	8	98	247
Dimethyldithiocarbamate, 0·1 mgm./gm., subcutaneous injection	2	68	265
	4	72	250
	6	78	260

* Bone marrow of grossly altered, fluid consistency, with considerable admixture of blood.

Some of the experiments with mustard gas and its derivatives were carried out as part of extra-mural studies on behalf of the Ministry of Supply; thanks are due to the Chief Scientist, Ministry of Supply, for permission to publish the results. The study of bone marrow metabolism is supported by a personal grant to the author from the Medical Research Council.

[1] Lutwak-Mann, C., *Biochem. J.*, **41**, *Proc.* xxx (1947).
[2] Needham, D. M., Cohen, J., A., and Barrett, A. M., *Biochem. J.*, **41**, 631 (1947).
[3] Lutwak-Mann, C., Report to Ministry of Supply by Dr. Malcolm Dixon, No. 32 (1947).
[4] Lutwak-Mann, C., and Gunz, F. W., *Biochem. J.*, **44**, *Proc.* iii (1949).

SCIENCE IN ADULT EDUCATION

TWO years ago at Dundee the Council of the British Association asked the Education Section to consider what could be done to stimulate more interest in science in the sphere of adult education. As a result a committee to explore this question was established jointly by the National Foundation for Adult Education and the British Association; and it has recently issued an interim report. One of the sessions of the Education Section of the British Association at the Newcastle meeting was devoted to a discussion of this report.

The discussion was opened by Mr. W. O. Lester Smith, who had been chairman of the joint committee. Emphasizing the interim character of the report, he said that the aim of the committee has been to produce some practical suggestions which might bring early results; they are well aware, however, that there are fundamental issues which require consideration and that there is room for a report of a long-term character. He paid a tribute to the services rendered by Mr. E. M. Hutchinson as secretary of the joint committee, and commented upon the help given by directors of extra-mural departments and secretaries of Workers' Educational Association districts, and also by many tutors, especially those who are actively engaged in promoting courses in scientific studies.

The president of the Education Section, Sir Fred Clarke, was in the chair, and he rightly described the discussion as valuable and helpful. Among the many

who contributed to the discussion were several members of the joint committee, including Mr. Hutchinson, Prof. Winifred Cullis, Dr. Maxwell Garnett and Dr. P. F. R. Venables. It is clear that the interim report met with general acceptance, and there was a strong feeling that if the Ministry of Education, local education authorities, university extra-mural departments, and voluntary associations like the Workers' Educational Association would implement its recommendations substantial advance would ensue. Mr. Lester Smith remarked upon the whole-hearted way in which the Ministry had co-operated with the joint committee, and commented upon the valuable help given at its meetings by Mr. H. R. D'Aeth, an inspector from the Ministry of Education.

The outstanding feature of the discussion was the emphasis upon the need of recruiting for the teaching of science to adult classes suitably qualified tutors with a flair for such work. This crucial need has been stressed before, notably in a report published by the British Association in 1933 on "Science Teaching in Adult Education", and in a report of the Adult Education Committee of the Board of Education in 1927 on "Natural Science in Adult Education". The evidence shows unmistakably that where extra-mural departments have appointed staff tutors in science there has been healthy advance. For example, in the Cambridge extra-mural area the percentage of classes in natural science subjects has risen in recent years to 16 per cent against a figure of 4·5 per cent for the whole of Great Britain.

Prof. Winifred Cullis observed that in her lifetime she had witnessed a remarkable growth of interest in the biological sciences, and remarked on the appeal that they made to members of women's organisations. Reference was made to a table of "interest ratings" quoted in the report, which show that health has become interest No. 1, followed closely by interest in new developments, the application of science to industry, and psychology; while "fundamentals of physics and chemistry" rank as low as nineteenth. There seemed to be general agreement at this meeting that tutors and discussion-group leaders must be men and women with an appreciation of the implications of science for personal and social life. There was much discussion as to whether current tendencies in university and technical education help to produce that all-round view of science which enables the tutor to interest the inquiring student. Reference was made to the 1944 report of the British Association committee on post-war university education, and to its reminder that "separate specialisms tend to be increasingly divorced from the life of the community". It was contended that an issue like that of population and food, with which Sir John Russell had dealt so cogently in his presidential address, is the kind of topic which should arouse the interest of students in adult education classes. Tutors who can establish a liaison between the natural and social sciences are the most likely to meet with success.

It was decided to invite the co-operation of other sections of the Association in stimulating the study of science in the adult education field; and there was general endorsement of the recommendations of the report, of which the principal ones are: (1) that university extra-mural departments should make staff appointments of people competent to teach and organise classes in science; (2) that local education authorities should give sympathetic consideration to requests for assistance regarding accommodation, transport of apparatus, and provision of visual aid equipment; (3) that local advisory committees for adult education should foster a liberal approach to vocational studies in colleges of further education; (4) that the Association of Tutors in Adult Education should, through its branch meetings and otherwise, give special attention to the relation in class teaching between the natural and the social sciences.

PSYCHOLOGY AND TEACHING

THE final session, on September 7, of Section J (Psychology) of the British Association at the Newcastle upon Tyne meeting was devoted to three papers on ways in which psychology and professional psychologists can contribute to the improvement of teaching. Mr. J. Lumsden surveyed the whole field and pointed out that while the aims of education are largely determined by non-psychological interests, these aims cannot be brought to fruition unless children can be influenced in their development along the desired lines by teachers who have been trained to understand the mental growth of children. By reason of the shortness of the course and the immaturity of the college students, this training can only be simple and general and closely applied to their experience of children. It cannot cover many of the less usual problems of teaching. Therefore, it should be under the direction of a well-qualified psychologist who can not only bring into the college the results of research, but can also impress it on the students that circumstances may arise in which it is no confession of failure to seek advice from a consultant educational psychologist.

Something approaching a school psychological service, staffed by professional educational psychologists, has in some places been developed, and could be elsewhere but for shortage of staff. Its main function would be to assist teachers who asked for its help on problems of learning and behaviour. It would be a mistake to think its usefulness should be restricted to handicapped children or the maladjusted; one of its functions would be to advise on suitable forms of special education for the former and, in co-operation with the School and National Health Services, to diagnose and treat the latter. Apart from this case-work, such a service could offer useful advice to teachers and authorities on questions of normal educational practice, including examinations and records, and selection of children for different forms of secondary education; on the design and provision of equipment and apparatus; and, in some such way as the industrial psychologist does in factories, on the influence of working conditions in schools upon efficiency. A school psychological service should also be a channel through which information might reach teachers on the ways in which their classroom work might influence the mental health of the next generation and promote better social and international understanding.

Following this general survey, Miss C. M. McCallum gave a description of the function and aims of one such psychological service—that of Glasgow—which restricts itself to dealing with children who for one reason or another are failures, in school or society. Dealing with three thousand cases annually in twelve clinics, the service trains its own workers, who are all teachers with a postgraduate degree in education and psychology. She traced most failures to an

unsatisfactory resolution of the conflict between personal desires and social standards, and maintained the view that the psychologist must not be neutral in this conflict, but must support the ethical conventions of the society which employs him. She condemned the tendency to consider all forms of anti-social behaviour as symptoms of mental illness or imbalance. This would hinder both prevention and cure, which consist in assisting both parents and teachers to train children better so that they have the security of both affection and discipline to enable them to face the vicissitudes of life and enjoy the struggle.

Failure can be understood if the answers to the following three questions can be found: "What challenge in his own life has the child failed to meet?" "Why has he failed?" "Why has his failure resulted in this particular symptom?" Failures referred to the service are usually failures in learning, failures in behaviour, or failures to be happy—the backward, the delinquent and the neurotic.

Even those backward by low intelligence can be trained to make the best rather than the worst of their poor endowment. Assiduous work and good habits can overcome much of that handicap. Intelligent children who are backward have usually never learned to expend effort on jobs they dislike. The reason may be found in faulty home-training; but severe mental conflict may have the same apparent result, and cases must be carefully distinguished.

With the delinquent, Miss McCallum deprecated the popular view that psychological treatment can be a substitute for basic character training. The ordinary parent and teacher are more aware of possible dangers to child development from excessive discipline than of the need for it, and as a result many children hold all authority in contempt. Some delinquency is, however, the result of emotional breakdown and requires skilled investigation and treatment, and must not be confused with that due to lack of control.

Many of the neurotic children are best treated at the residential clinic and school, where individual lines of treatment can be carried out through the whole twenty-four hours, while the children are following all the activities of a good boarding-school and some of those of the home. On following up the after-histories of children who have spent three to twelve months in residence, 80 per cent of successes are claimed.

Over the whole service the greatest stress is laid on co-operation with teachers, who receive reports on their children in non-technical language, and visits to advise them on the important part they can play in treatment. Influencing the child through parent and teacher is more effective than the direct intervention of the psychologist.

The third paper at this session was by Prof. E. A. Peel, who gave examples of objective investigations which have cast light on practical educational problems. One of the fundamental difficulties of research is to decide upon a sound and acceptable educational criterion. This is rather less difficult in experiments on classifying pupils than in those dealing with the efficacy of teaching methods, and possibly for this reason more work has been done in this field. The work of Burt and Thomson has given us a picture of the field of special abilities significant for education. To educational, practical or mechanical and æsthetic factors, and a factor dealing with the use of words and ideas, Prof. Peel would add one of interest, though the last is difficult to test in the absence of a suitable criterion. A projection test of some kind might serve. The rather negative results of experiments designed to show whether the structure of abilities becomes more differentiated with increase in age might be due to the narrow range of ages experimented upon, mainly eleven to fourteen.

The only moderately high predictive value of tests of success in grammar schools is, as a result of experiment, being raised. Investigations on the practice effect of re-tests suggest that the effect varies with intelligence. Analysis of the different ways in which different teachers assess personality might improve the possibility of obtaining reliable forecasts from teachers.

As examples of research on teaching methods, the work of Burt and Lewis on methods of teaching reading to the backward was mentioned. The dull require different methods from the bright. It is noteworthy that while a change of method might be an advantage with reading, it is a disadvantage with arithmetic. The present position of formal training is that practically all learning is specific except for identical elements, the most important of which are consciously apprehended techniques and ideals. How the results of such experimental work could best be brought to the attention of teachers he left to others.

INSTITUT PASTEUR DE KINDIA, FRENCH GUINEA

THE Institut Pasteur of Kindia lies in the bush, 7 kilometres from the town of Kindia and 150 kilometres from the port of Conakry, French Guinea. It was founded in 1925 by Dr. Calmette, formerly director of the Institut Pasteur of Paris, as a centre for research on the anthropoid apes, since it was felt that these animals would provide better experimental material in their natural surroundings and climate. Its first director was Commandant Wilbert, who was assisted by Capitaine Delorme. The actual Institute consists of three houses to accommodate the staff and two laboratory buildings. There is also a small hostel for visiting workers. Water is obtained by draining the plateau above the Institute, and the Institute generates its own electricity. It owns land covering some hundred acres and used partly to grow food for the monkeys and partly to accommodate the menagerie, the monkey house and the chimpanzee enclosure.

One of the main studies made with the chimpanzees has been tests of the anti-tuberculosis vaccine B.C.G. (bacille Calmette Guérin). Experiments have also been carried out on the transmission of leprosy, but with negative results. As part of its routine work the Institute carries out microbiological analyses, and is frequently called upon to make diagnoses of rabies, which is very common in French Guinea. During the War the Institute had to restrict its activities and to specialize in the preparation of smallpox vaccines and in obtaining snake venoms for anti-venom sera. Since the War the preparation of dry vaccine has been abandoned because the institutes in France have better facilities for producing vaccines of high virulence at a low cost. On the other hand, owing to the difficulties which the Institut Pasteur of Paris has encountered in obtaining snake venom from tropical regions, the Institut Pasteur of Kindia has had to develop this side of its activities. It has

therefore added a snake-house so that it can send regular supplies of venom to Paris; and it has, in fact, become the French African centre for research on snakes. The Institute also acts as a depot for the supply of anthropoid apes to France and sends to the Institut Pasteur of Paris some two hundred a year.

The Council of Administration of the Institut Pasteur of Paris has recently decided to strengthen the Kindia Institute, to enable it to resume its pre-war activities. The staff now consists of a medical director, assisted by a veterinary surgeon and a team of technical assistants. The director, Colonel Lefrou, is very anxious to be kept informed of research in Great Britain in the fields in which he is particularly interested—anthropology, biology and zoology—and would be glad to receive scientific literature. He would send in return reprints of the Institute's reports, which will appear, as in the past, in the *Bulletin de la Société de Pathologie Exotique* or in the *Annales de l'Institut Pasteur*. He would also welcome any inquiries from British research workers who are interested in the Institute's activities, to be addressed to: Le Médecin Colonel Lefrou, Directeur de l'Institut Pasteur, Kindia, Guinée Française.

MARINE BIOLOGY IN BRITAIN

THE annual reports* of three British marine biological laboratories have recently been published. In each case the period under review has been one of post-war re-organisation and expanding activity.

The report of the Millport Laboratory of the Scottish Marine Biological Association appears in a larger format than formerly, and is bound inside a common cover, with copies of all scientific papers published from the Laboratory in the course of the year. These 'collected reprints' will not only form a useful exchange for the publications of other laboratories, but will also, for the first time, provide an adequate indication of the scope of the work carried out at Millport.

The Laboratory's 40-ft. vessel *Nautilus*, which has given such good service since 1923 and is well known to many biologists, has now been replaced by a new and larger ship—a 75-ft. Admiralty-built motor fishing vessel which has been extensively altered and refitted to adapt her for scientific research work. Her name, fittingly enough, is *Calanus*, after a small planktonic crustacean, important as fish food, on which much productive research has been done at Millport. A photograph of the *Calanus* and her predecessor, the *Nautilus*, forms a frontispiece to the report.

During the year covered by the report, the staff was enlarged by the appointment of an algologist and an additional zoologist, and Dr. A. P. Orr, a senior member, was made deputy director on assuming special responsibilities in respect of the new and larger ship. The scientific work of the station, in full swing on an increased scale, covered plankton investigations, oyster culture, life-histories and growth-rates of marine algæ, anti-fouling researches, structure and habits of molluscs, and general faunistic observations.

The Port Erin Laboratory, Isle of Man, likewise reports additions to its staff and increasing activity on a wider scientific front made possible by the acquisition of a motor research vessel, a 61½-ft. Admiralty motor fishing vessel suitably converted, and christened the *William Herdman*. She is equipped for seine-netting in addition to trawling and is fitted with an outboard type of echo-sounder. Immediately the ship became available, in September 1948, biological investigations at sea were put in hand, particular efforts being made to discover and survey herring spawning grounds. Plankton studies and researches into the life-histories of marine animals and plants are also being carried out.

At the Dove Marine Laboratory, Cullercoats, research is also proceeding actively. All members of the staff have taken part in an important survey of the marine fauna of the district, an ambitious programme of which much yet remains to be done, especially below low-water mark. In addition, an intensive study of salmon in the fishery district of the River Tyne has been completed, and an investigation into the physico-chemical conditions in estuarine muds, with special reference to the evolution and absorption of phosphates, has been begun.

After reading these reports, one is left in no doubt that marine biological research in Great Britain, after the relative stagnation of war-time, is now restored to full and vigorously growing activity. This is most welcome news, for there is, indeed, much to do in every branch of the subject. G. A. STEVEN

* The Scottish Marine Biological Association: Report of the Executive to the Council for the year to March 31, 1948. Pp. 36. (Marine Station, Keppel Pier, Millport, Isle of Cumbrae.) n.p.
The Marine Biological Station, Port Erin, Isle of Man: Annual Report (No. 61) for 1948. (University Press of Liverpool, June 1949.) 3*s*.
The Dove Marine Laboratory, Cullercoats, Northumberland: Report for the Year ending July 31, 1947. (Newcastle upon Tyne: Marine Laboratory Committee of King's College, 1949.) 5*s*.

FOURTEENTH INTERNATIONAL VETERINARY CONGRESS

MORE than a thousand delegates and members from fifty-three countries attended the recent International Veterinary Congress held in London. The theme of the Congress was the contribution of the veterinary profession to world food supplies, and Lord Boyd Orr expressed the view that "if the control of animal diseases could be organised on a world-wide basis, there is no doubt that with our present knowledge we could enormously increase the amount of dairy and meat products available for human consumption". He went on to say: "Here then is a great field for veterinary science. Unfortunately, like all other branches of biological science which seek to enrich the world in the equal interest of the people of all countries, it is starved of funds. The veterinary profession needs a strong international organisation on the lines of the World Health Organisation, through which Governments could co-operate more actively in the elimination of preventable diseases on a world scale."

Both the lectures delivered in plenary session and the papers presented at the thirty-one sectional meetings were largely concerned with veterinary preventive medicine. There was considerable emphasis upon measures for improving the health of whole herds and for controlling disease upon the widest scale, national and international—a fact which must have impressed any layman who still thought of the veterinary surgeon as someone who merely treats the individual animal after it has become ill or injured.

The work of Sir Arnold Theiler and other veterinarians in South Africa, who demonstrated in 1926 the relationship between botulism in cattle and phosphorus deficiency in the grazing, is well known. They showed not only that the disease was contracted by the cattle eating the bones of infected carcases, but also that the feeding of a bone-meal supplement would overcome this craving and hence greatly reduce the incidence of botulism. M. Sterne and L. M. Wertzel, in a paper on the subject, stated: "It is no understatement to say that much of the subcontinent was opened to ranching by the discovery of the value of a bone-meal supplement. Twenty years ago it was barely possible to keep cattle in the Vryburg district. This is now an opulent ranching area and boasts the largest dairy and creamery in the country."

Dr. C. S. M. Hopkirk instanced the large-scale results of applied veterinary science in relation to cobalt and copper deficiencies. "In New Zealand," he said, "thousands of acres of virgin country which would not bear stock have been turned into fertile land giving increasing yields of meat and milk." It was not until 1946 that hypocupræmic disorders of cattle in Great Britain were suspected. A paper submitted to the Congress by S. Jamieson[1] and Ruth Allcroft[2] described their findings in Caithness, where a pining condition in beef calves—associated with a very low copper status of the animal, but with normal copper content of the pastures—occurs.

By way of contrast, Dr. L. B. Bull, from Australia, described a condition of chronic copper poisoning from which grazing sheep may die when they consume pasture plants containing abnormal amounts of copper taken up from cupriferous soils. The contamination of surface soil and pasture plant by copper-containing dust from waste dumps around copper mines may also lead to the development of the disease. Grazing sheep may also develop the disease on certain acid soils with normal copper content, or in exceptional seasons favouring early autumn growth of non-gramineous annual plants. For example, the disease has been observed in sheep grazing on pastures dominated by *Trifolium subterraneum*. It is suggested that a high copper/molybdenum ratio favours assimilation of copper under these conditions. The disease also occurs in a proportion of sheep which have developed poisoning from grazing *Heliotropium europæum*. Under any of these conditions the disease is precipitated by a falling plane of nutrition, by fasting and by physical exertion.

There were a number of papers dealing with virus diseases. Three Swedish veterinarians[3] described the results of some experimental work on swine influenza, from which it would appear that the pneumonia associated with that disease may be produced by the virus alone, without the aid of secondary bacterial invaders. An investigation into the viability of the virus of swine fever was carried out in Australia[4] following the re-introduction of that disease (afterwards eradicated again within five months) in 1942.

Experiments with frozen pork held at 12° F. from pigs killed in the incipient stages of swine fever showed that the virus remains viable for 1,598 days and probably longer. Bacon prepared from pigs killed in the incipient stage of swine fever was capable of setting up infection after 27 days, but was non-infective after 57 days. Repeated exposures of susceptible pigs to an infected environment indicated that they became infected 24 hours after infected pigs had been removed from the environment, but not after 48 hours.

Dr. A. M. Diesel described a new epizootic in southern Africa affecting cattle only. It is an acute febrile infectious disease characterized by 'lumps' in the skin. Morbidity is usually 50–100 per cent. Mortality may reach 75 per cent but is usually about 1 per cent. The disease is probably due to a filtrable virus 13 mμ in diameter. Virus strains have been isolated, cultivated on eggs, and the egg-culture virus has produced 'lumpy skin disease' in cattle. The disease can be transmitted experimentally by inoculation of infected blood and tissue material. Its natural method of spread is unknown, but is believed to be chiefly through the medium of an insect vector favouring moist conditions. The disease was first reported in Northern Rhodesia during 1929–30, and during 1943–45 it spread with great rapidity through the Union of South Africa. It has a profound effect on the economy of intensive cattle farming, and the usual quarantine measures have little effect in controlling the spread of the disease. Research has as yet not produced a vaccine, but it is felt that this is likely to be the only means of controlling the disease successfully.

Foot-and-mouth and rinderpest were among other virus diseases dealt with. The pioneer work of Dr. J. T. Edwards and the use of the caprinized virus which he introduced were discussed, as also the less virulent lapinized[5] rinderpest vaccine used successfully in China.

One of the most important subjects was that of infertility and its hereditary, nutritional, environmental and bacterial aspects, all of which are receiving increasing attention. A hereditary hypoplasia of the reproductive organs in both bull and cow have been shown to be of considerable importance[6]. In Great Britain, S. L. Hignett has attributed much bovine infertility to a disturbance of the calcium-phosphorus ratio in the food intake, and has shown that one type of infertility may be associated with heavy liming of the pastures. The part played in the control of venereal disease of cattle by artificial insemination, and the use of *S.*19 vaccine against brucellosis were referred to by many speakers at the Congress. The eradication of bovine tuberculosis also received much attention, especially the highly successful results achieved in Denmark. In 1937 less than half the herds there were tuberculin-tested, and only 26·5 per cent were free of reactors; last year the comparable figures were 99·9 and 99·2. The problem, however, is an administrative rather than a scientific one.

The last two days of the Congress were shared with the National Veterinary Medical Association. "Diseases of Household Animals communicable to Man"[7] and "Leptospirosis"[8] were among the papers discussed. *Leptospira canicola* accounts for much kidney disease in dogs and for the mild influenza-like canicola fever in man. The treatment of fractures by medullary pinning[9] also received considerable attention.

[1] Jamieson, S., and Russell, F. C., *Nature*, **157**, 22 (1946).
[2] Allcroft, R., *Nature*, **158**, 796 (1946).
[3] Hjarre, A., Bakos, K., and Nordberg, B. K., Proc. 14th Int. Vet. Cong. (1949) (in the press).
[4] Edgar, G., Hart, L., and Hayston, J. T.
[5] Kesteven, K. L.
[6] Finlay, G. F.
[7] Winsser, J.
[8] Joshua, J. O., and Broom, J. C.
[9] Nielsen, H. Moltzen, and Knowles, J. O.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Absorption of Metallic Cobalt-60 from a Subcutaneous Site

THE possibility of using cobalt-60 interstitially as a source of radiation for therapeutic purposes prompted preliminary investigation of its behaviour when implanted subcutaneously. It is known that cobalt when administered to animals in sufficient quantities produces evidences of systemic toxicity[1–3]. There are also reports of the development of sterile abscesses at the site of injection of inactive cobaltous chloride[4]. It was anticipated, therefore, that metallic cobalt might produce a tissue reaction which would make its use as a bare needle or seed inadmissible. Another possibility was that particles of the metal might be absorbed by the animal and deposited or excreted in measurable amounts.

Experiments were, therefore, carried out using mature rats and metallic cobalt. The cobalt was inserted with aseptic precautions through a small slit in the loose skin of the right side and deposited dorsally a short distance from the incision. Each operation was carried out first with inactive cobalt (cobalt-59) and repeated with radioactive cobalt (cobalt-60). The animals tolerated the procedure well and were sacrificed after periods varying from four to fifteen days.

Both fine wire and flat disks were used for implantation. The wire (0·01 in. diameter) was cut into lengths about 1 in. long weighing approximately 0·008 gm. Implants were made of bare wire, wire covered with gold 0·003 in. thick, and wire with gold covering half its length. It was estimated that each sample contained 24 microcuries of cobalt-60. In one experiment a packet of bare wire with an activity of 211 microcuries and weighing 0·1 gm. was implanted.

When the animals were sacrificed, all those implanted with bare cobalt (active or inactive) showed a localized inflammatory tissue reaction which was mild on the fourth day but marked on the fourteenth day. When gold-covered cobalt was used, the only tissue reactions were at the open ends of the gold tubes, except in one animal where a reaction occurred at a point where the gold had been broken.

The radioactivity of the tissue removed from the vicinity of the implanted metal was investigated, as well as that of subcutaneous tissue away from the site of the implant, and of liver, kidneys, spleen, excreta and remaining carcase. Using a Geiger–Müller II counter and standard scaling unit, tissues which had been in the vicinity of cobalt-60 wire for four days yielded counts as high as ten times background. The tissue from the vicinity of the 211-microcurie packet gave seventy times background. Although no attempt was made in this series of experiments to determine the quantity of cobalt absorbed, tissues which had been near the bare radioactive wire were found to be more active than tissues near the gold-covered cobalt. Also, by using the probe of a scintillation counter to scan the block of tissue, it could be demonstrated that the activity in the tissue increased up to the position where the wire had been implanted. The gold-covered material appeared both to impede the absorption of cobalt and to prevent the development of local tissue reactions. Additional experiments using sealed gold tubes are in progress.

In another group of animals, active and inactive bare cobalt disks varying in diameter from 0·4 in. to 1 in. and weighing 0·3–2·4 gm. were implanted. The activity of the disks varied from 0·36 millicurie to 2·47 millicuries.

These rats were killed on the fourth or on the fifteenth day after implantation. In all animals the disks (active and inactive) were found to be surrounded by granulating tissue which not infrequently contained purulent material. The tissues taken from the site of the implant yielded counts up to ninety-five times background. The liver, kidneys, excreta and remaining carcase were less active but still measurable. No radioactivity was detected from the spleen or subcutaneous tissues removed from areas away from the site of the implant.

Measurable activity appeared in the excreta within the first twenty-four hours and persisted throughout the time of the experiment. An animal with a disk containing 2·47 millicuries of cobalt-60 excreted at an approximately constant rate 0·15 microcurie per twenty-four hours for fifteen days. Animals with smaller implants excreted correspondingly less active cobalt.

At the end of the experiment, the cobalt disks showed a loss of weight of 0·5–2·3 mgm. The disks showing the greatest loss of weight were from the animals the tissues of which were most active.

From these preliminary experiments it is apparent that bare metallic cobalt-60 can be absorbed from a subcutaneous site and may be found in the adjacent subcutaneous tissues, in the liver, kidneys, remaining carcase and in the excreta. It is clear that neither cobalt-60 nor its alloys should be used parenterally without prior investigation of possible absorption.

M. NICKSON*
L. F. LAMERTON
W. V. MAYNEORD

Physics Department,
The Royal Cancer Hospital,
London, S.W.3.

Aug. 29.

* Research fellow from the Sloan Kettering Institute for Cancer Research, New York.

[1] Waltner, K., and Waltner, K., *Klin. Woch.*, **8**, 313 (1929).
[2] Griffith, W. H., Pavcek, P. L., and Mulford, D. J., *J. Nutrition*, **23**, 603 (1942).
[3] Frost, D. V., Spitzer, E. H., Elvehjem, C. A., and Hart, E. B., *Amer. J. Physiol.*, **134**, 746 (1941).
[4] Goodman, J., *Proc. Soc. Exp. Biol.*, **64**, 336 (1947).

Preparation of Radioactive Hydrogen Sulphide

SOURCES of sulphur-35 of high specific activity are commonly prepared by the irradiation of potassium chloride in an atomic pile. Thermal neutrons produce an (n,p) reaction in the chlorine-35 isotope. It is known to be difficult, if not impossible, to extract the sulphur from the irradiated material, other than in the form of a sulphate.

Since biochemists and others desire the sulphur in a more reactive form, we wish to report an observation made during a more detailed study of the chemical effects of the above nuclear reaction. If rubidium instead of potassium chloride be irradiated, we have found that about 50 per cent of the active sulphur can be separated as hydrogen sulphide by treatment of the irradiated salt with aqueous hydrochloric acid

containing a trace of hydrogen sulphide as carrier. Separation from active rubidium can easily exceed 99·99 per cent efficiency. The rubidium salt need not be specially treated, nor need the irradiation be conducted *in vacuo*. Thus the sulphur-35 formed by the (n,p) reaction in chlorine-35 behaves similarly to that produced by the (d,α) reaction in chlorine-37 in the same medium[1]. Comparison of the behaviour of the sulphur in the potassium and rubidium chloride crystals makes the explanation advanced by W. S. Koski[2] for the case of the potassium chloride difficult to accept.

One of us (U. C.) is indebted to the Consiglio Nazionale delle Ricerche, Rome, for the opportunity of carrying out this investigation.

U. Croatto
A. G. Maddock

Radiochemical Laboratory,
Department of Chemistry,
Cambridge.
Sept. 5.

[1] Kamen, M. D., *Phys. Rev.*, [ii], **60**, 537 (1941).
[2] Koski, W. S., *J. Chem. Phys.*, **17**, 582 (1949).

'Long-Term' Adaptation and Non-Mendelian Inheritance in Yeast

Haplophase yeasts capable of fermenting galactose ordinarily produce gas in from sixteen to thirty-six hours at 30° C. after inoculation into nutrient medium containing galactose. Winge and Roberts[1] studied clones which fermented the sugar in from three to fourteen days after they were seeded in galactose yeast extract medium. Following the adaptation period, however, the rate of fermentation was identical with that of ordinary galactose-fermenting yeasts. In their analyses, they found that two haploid segregants from asci heterozygous for galactose fermentation were the ordinary fast fermenters and the other two were 'long-term' adapting clones. They attributed the delay in fermentation of the 'long-term' adapting segregants to the time required by the cells in the haploid population to build up galactozymase to a concentration sufficient for the detection of its presence. The regular segregations of fast/'long-term' adapting phenotypes among the haploid progeny were offered as proof that delayed fermentation of galactose is controlled by a specific allele. Such originally 2 : 2 fast/'long-term' tetrads were transformed into 4 : 0 fast/'long-term' ratios by extended cultivation in galactose yeast extract medium. Winge and Roberts considered that under these conditions there was no change in the population but merely a 'long-term' adaptation of the entire population. In proposing this view, they denied the occurrence of mutations as a factor operative in the 'long-term' adaptation, and held that de-adaptation of an adapted clone, as well as its subsequent re-adaptation to galactose, were effected through a 'modification'.

Allelism of a single pair of galactose genes (G/g) was established by Lindegren and Lindegren[2]. The G allele controls rapid fermentation of galactose, while cells bearing the other (g) do not produce detectable gas under the conditions of the Durham-tube fermentation test.

Mundkur and Lindegren[3] analysed extensive pedigrees of *Saccharomyces* hybrids involving 'long-term' adapting segregants (g_s). These clones resembled Winge and Roberts's cultures in that they fermented galactose after a variable period of contact with the sugar ranging from four to twenty-five days. This variable period is, in itself, a strong indication that delayed fermentation is not conditioned by a specific g_s allele. Moreover, in some pedigrees, with matings heterozygous for G/g_s, less than half the number of segregants was g_s; this fact cannot be accounted for on the view that 'long-term' adaptation is controlled by a specific g_s gene. Furthermore, the frequency of g_s progeny from $G \times g_s$ matings was about the same as that in $G \times g$ matings (where the g parent descended from a $G \times g_s$ cross).

These observations suggested that 'long-term' adaptation could result from a mutation in galactose medium of originally non-fermenter g segregants to the G allele, with a consequent population shift and the expression of the fermenter phenotype.

To test this view, 230 glucose-grown cells of a segregant known to be g_s were seeded into 0·5 c.c. glucose broth. This inoculum was derived from a glucose agar slant (not from a fermentation tube in which gas had already accumulated). The mature population in each of twenty such tubes amounted to approximately 203 million cells. Twenty galactose agar plates were poured from these twenty tubes, using the entire mature population in each case. Variable numbers of large colonies (from 0 to 19) developed on different galactose plates amid millions of non-fermenter, g cells. These large colonies presumably comprised fast-fermenter mutants (G), and when cells from one such large colony were mated with a standard G haplophase, only fast-fermenter, G progeny, were obtained. That cytoplasmic effects were not involved in this cross was shown by the following experiment: the G mutant (derived from the supposedly 'long-term' adapting clone) was mated to a standard g clone descended from a pedigree in which G/g segregated regularly. Half the progeny were G whereas the other half comprised g and g_s segregants in about equal numbers.

These analyses have demonstrated that 'long-term' adaptation results from a mutation and selection of G clones descended from originally g segregants, and that g_s clones in effect comprise mixtures of g and G cells; this capacity for mutation is characteristic of certain lines, in which it occurs with unusually high frequency and is heritable. The chance of a clone being diagnosed as a 'long-term' adapting segregant depends on the original g segregant mutating to G.

The above observations raised the question whether there was a valid basis for inferring the occurrence of non-Mendelian segregations cited in Lindegren and Lindegren[2]. Certain crosses heterozygous for galactose and melibiose fermentations (G/g; ME/me) yielded more than the two expected fermenter segregants. The extra-fermenters are interpreted[4] as resulting from conversion of the recessive, non-fermenter alleles to dominance in the heterozygote.

The phenomenon of 'long-term' adaptation suggested that the extra-fermenters in $G\,G\,G\,g$ and $G\,G\,G\,G$ (or *ME ME ME me* and *ME ME ME ME*) tetrads could have arisen from mutations occurring after the spore had germinated. However, the fact that the extra-fermenters in non-Mendelian tetrads ferment as rapidly as the *bona fide* fermenter segregants makes this phenomenon different from that encountered in 'long-term' adapting pedigrees. In the latter case, the number of days elapsing before a slow clone ferments is very variable, and this is indicative of chance mutation (g to G); however, an

irregular tetrad is diagnosed as such only if more than the expected number of segregants ferment simultaneously (usually within eighteen hours), or if greater than the expected number of segregants do not ferment over an extended period of time.

To test the validity of the conversion theory, genetically stable, standard *g* and *me* clones were mated to *G* and *ME* clones from a converting pedigree. Tetrads derived from this mating were characterized for fermentative and vitamin-synthesizing abilities and mating-type specificities. A sufficient number of marker genes was used to establish hybridity beyond any question. The abilities of the haploid progeny from these hybrid asci to ferment galactose and melibiose were tested at two growth-periods: (1) after the segregant had achieved luxuriant growth on glucose agar; and (2) shortly after the spore had been isolated from the ascus when the cell population was still very small.

These analyses[5] revealed consistent correlations between phenotypes of the same segregant at the two growth-phases, and confirmed the initially *G* and *ME* genotypes of the extra-fermenters in non-Mendelian tetrads. They exclude the possibility that the latter result from chance mutation of originally *g* and *me* spores, and suggest that irregular segregations of fermentative abilities may originate in the heterozygote. Additional data have shown that polysomy and polyploidy are inadequate as explanations of the irregular segregations encountered.

This work was supported by grants from Anheuser-Busch, Inc.

BALAJI D. MUNDKUR

Southern Illinois University,
Carbondale, Illinois. March 28.

[1] Winge, O., and Roberts, C., *C.R. Lab. Carlsberg (Physiol.)*, **24**, 263 (1948).
[2] Lindegren, C. C., and Lindegren, G., Cold Spring Harbor Symp. Quant. Biol., **11**, 115 (1947).
[3] Mundkur, B. D., and Lindegren, C. C., *Amer. J. Bot.* (in the press).
[4] Lindegren, C. C., "The Yeast Cell" (Educational Publishers, St. Louis, 1949).
[5] Mundkur, B. D., *Ann. Missouri Bot. Gard.*, **36**, 259 (1949).

Photoperiodism and Diapause in Insects

DURING the past five years, work has been in progress at Rothamsted on rearing in the laboratory a number of plant-feeding insects. One of the aims has been to maintain supplies of insects in large numbers throughout the year. This has necessitated a study of the factors affecting diapause, the quiescent phase in which most plant-feeding insect species spend late autumn, winter and early spring.

Diapause has been studied in several insect species, but most attention has been paid to the tomato moth, *Diataraxia oleracea* L. This insect hibernates as a pupa and, as shown by Lloyd[1], a high percentage of pupæ in diapause is produced from larvæ reared in a glasshouse in spring and autumn, while around midsummer the pupæ produced are practically all non-diapause. Recently Speyer and Parr[2] showed that this occurred irrespective of temperature within the limits of 54–83° F., and concluded that diapause was induced by an innate factor and was not dependent upon environmental conditions.

Some three years ago, one of us (M. J. W.) found that if day-length during the larval period was increased to 16 hours a day by the use of artificial light (100-W. tungsten or 60-W. tubular fluorescent lamp) the number of pupæ in diapause produced in the winter months was reduced to 10–20 per cent. As a result, we have been able to rear some twenty-four generations of the tomato moth in the last three years.

An examination of the literature has shown no previous references to the effects of photoperiodism on insect diapause, and this factor is now being studied in further detail.

Batches of 40–50 tomato moth larvæ were reared in a constant temperature room at 75° F. under conditions of 24, 16, 8, 4 and 0 hours artificial light (60-W. tungsten lamp) per 24 hours and the percentages of pupæ in diapause determined in each treatment. These were as follow:

24 hr.	16 hr.	8 hr.	4 hr.	0 hr.
2	27	100	100	94 per cent

Further studies are at present in progress to determine the effects of light intensity, and the relationship, if any, between temperature and duration of light. It is possible that duration of light affects extent of feeding and that this in turn affects diapause. This and other factors will be studied.

Preliminary observations have shown that diapause in the large cabbage butterfly, *Pieris brassicæ*, and the cabbage moth, *Mamestra brassicæ*, may be prevented by artificial production of long days in winter, though in the latter species diapause has always occurred after three continuous generations, irrespective of length of day. Light has some effect on diapause in the mustard beetle, *Phædon cochleariæ*, but present observations suggest that the photoperiodic effect is relatively unimportant compared with that of temperature.

Detailed results of the above observations will be published elsewhere.

M. J. WAY
B. HOPKINS
P. M. SMITH

Insecticides Department,
Rothamsted Experimental Station,
Harpenden, Herts. May 10.

[1] Lloyd, Ll., *Ann. App. Biol.*, **7**, No. 1, 66 (1920).
[2] Speyer, E. R., and Parr, M. J., Rep. Exp. Res. Sta., Cheshunt, 41–60 (1947).

Growth and Sinus Glands in a Crab

Brown and Cunningham[1], Abramowitz[2], and Scudamore[3] clearly established the inhibitive influence of the sinus glands on the moulting of Crustacea. Removal of this gland in *Eriocheir sinensis* H. M. Edw. has enabled us to extend these observations, and show more clearly the influence of this gland on growth inhibition.

The intermoulting period of crabs of 4–6 cm. (diameter of carapace) is at least two or three times as long as those of 2–3 cm. crabs[4]. Table 1 shows that this difference between the two categories disappears if the sinus glands are removed.

Table 1

Date of removal	Interval between removal and moulting (days) 2–4 cm. carapace			4–6 cm. carapace			Water (t° C.)
March	41	$\sigma_m = 2{\cdot}9$	(5)*	—			12
April	38	$\sigma_m = 1{\cdot}0$	(16)	36·5		(2)*	13
May	29	$\sigma_m = 0{\cdot}9$	(10)	32	$\sigma_m = 1{\cdot}3$	(7)	15
June	22	$\sigma_m = 1{\cdot}5$	(11)	26·3	$\sigma_m = 0{\cdot}3$	(6)	16
July	17	$\sigma_m = 1{\cdot}5$	(11)	—			17
September	27	$\sigma_m = 1{\cdot}2$	(8)	23	$\sigma_m = 1{\cdot}4$	(7)	15

* The numbers in parentheses indicate the number of specimens used.

Table 2

Length of carapace	Rate of growth	
	Normal crabs	Glandless crabs
2–3 cm.	6·1 per cent (+ 1·57 mm.; σ_m = 0·17)	21·2 per cent (+ 5·61 mm.; σ_m = 0·49)
3–4 ,,	6·0 per cent (+ 1·84 mm.; σ_m = 0·18)	24·2 per cent (+ 8·84 mm.; σ_m = 0·81)
4–5 ,,		25·3 per cent (+ 10·6 mm.; σ_m = 0·78)

These results seem to indicate that the elongation factor of the intermoulting period in the larger crabs has been suppressed. In other words, the activity of the sinus glands apparently increases with the age of the individual and seems to be responsible for the decreasing number of moultings as the animal becomes older.

We have measured the rate of linear growth in normal and in glandless specimens, kept in aquaria (Table 2).

The rate of growth in the glandless specimens appears to be from three to four times higher. This extends the observations of Scudamore[3] on the Macrura to the Brachyura. The table also indicates that the well-known depressive effect of captivity on growth[5] is related to the sinus glands, since this effect disappears in the specimens from which the glands have been removed. We can eliminate diet as a factor responsible for these differences.

One additional fact confirms the primary role of the sinus glands as a growth-inhibiting factor. It is well known that the regeneration of legs and claws depresses growth following moulting (from 40 to 60 per cent according to Kamps[6]). We have observed that in animals deprived of their sinus glands such an inhibition disappears (Table 3).

Table 3

Sex and size	Regenerated	Rate of growth
♂ 39 mm.	4 legs, 1 claw	28·2 per cent
♀ 37 ,,	2 legs, 2 claws	24·8 ,,
♂♂ 32 ,,	3 legs	28·1 ,,
♂♂ 33·5 ,,	1 leg, 1 claw	27·7 ,,
♂♂ 36·5 ,,	1 leg, 1 claw	23·3 ,,

A detailed account of this work will be published in *Annales de la Société Royale Zoologique de Belgique*.

A. Bauchau

Laboratory of Zoophysiology,
University of Louvain,
71 rue de Namur,
Louvain.

[1] Brown and Cunningham, *Biol. Bull.*, **77**, 104 (1939).
[2] Abramowitz, R., and Abramowitz, A., *Biol. Bull.*, **78**, 179 (1940).
[3] Scudamore, H. H., *Physiol. Zool.*, **20**, 187 (1947).
[4] Schubert, K., Mit. Hamburg Zool. Mus. and Inst., **47**, 83 (1938).
[5] Drach, P., *Ann. Inst. Ocean.*, **19**, Fasc. 3 (1939).
[6] Kamps, L. F., thesis for doctorate, Gröningen (1937).

Immigration of Algæ into Danish Waters

Thanks to the careful studies of the late Prof. Rosenvinge on the vegetation of Algæ in Danish waters, particularly in the 'nineties, we are now able to study the changes since that time in the algal flora. An increase has occurred in this flora, amounting to five species during the past fifty years: the red alga, *Trailliella intricata* Batters; the two green algæ, *Codium dichotomum* (Huds.) Setchell (= *C. tomentosum* (Huds.) Stackh.) and *Codium fragile* (Sur.) Hariot (= *C. mucronatum* J.Ag.); and the brown algæ, *Dictyota dichotoma* (Huds.) Lamour. and *Colpomenia peregrina* Sauv. (= *C. sinuosa* var. *peregrina* Sauv.). The first three mentioned were recorded by Rosenvinge[1], the last two by Lund[2]. They are forms of a somewhat more southern origin, which have gradually spread towards the north; but the Danish localities are not their northernmost limits, for they were also met with on the west coast of Norway. They are all known from the coasts of Great Britain.

In 1948, I[4] was able to add another species to those mentioned above, namely, the subarctic brown alga *Fucus edentatus* De la Pyl. (= *F. inflatus* var. *edentatus* (De la Pyl.) Rosenv.), which was found in the northern part of the harbour of Copenhagen and in two neighbouring localities of the Sound. Until recent times the southern limit of the species in Europe was the Faroes, the Shetland Isles and South Norway, but during the 'twenties it was found in a few localities on the west coast of Sweden[5], and later it has apparently been spreading in a southward direction to the Sound. It may also have spread from the Shetland Isles to the east coast of Scotland, for which reason I wish to direct the attention of British naturalists to it.

The most characteristic features of the species are its narrow, entire, evesiculate thallus, the indistinctness or lack of the midrib in the upper part of the shoots and its linear or cylindrical, hermaphrodite receptacles. In Danish plants the length was 20–25 cm., the breadth 0·4–0·6 cm., the receptacles measuring 3–5 × 0·5–0·6 cm. In places where the renewal of the water was not very good, it was forming associations from the surface to a depth of about 2 m. (at Copenhagen the difference between ebb and flow is nearly imperceptible). In localities with a better renewal of the water, its number decreased very much in favour of *Fucus serratus* and *F. vesiculosus*; but on the other hand, it showed better development in such localities.

The species seems to be comparatively insensitive to the salinity and its fluctuations. At Copenhagen the salinity of the surface water generally only amounts to about 10 ‰, now and then, however, exceeding 20 ‰; the mean value is 11·7 ‰. But at the Faroes and elsewhere it exists under the conditions of high salinity of the ocean water.

The find at the Shetlands was made by Börgesen[6], but this statement must have been overlooked by Newton[7], who does not mention the species.

Sören Lund

Danish Biological Station,
Charlottenlund.
April 20.

[1] Rosenvinge, L. K., *Bot. Tidsskr., Copenh.*, **37**, 125 (1920).
[2] Lund, S., *Bot. Tidsskr., Copenh.*, **45**, 180 (1940).
[3] Lund, S., Rep. Danish Biol. Sta., **47**, 3 (1945).
[4] Lund, S., *Bot. Tidsskr.*, **48** (in the press, 1949).
[5] Hylmö, D. E., *Bot. Notiser, Lund*, 377 (1933).
[6] Börgesen, F., *J. Bot.*, **41**, 304 (1903).
[7] Newton, Lily, "A Handbook of the British Seaweeds" (London, 1931).

Piercing Mouth-Parts in the Biting Lice (Mallophaga)

THE Mallophaga, ectoparasites of birds and mammals, are distinguished within the order Phthiraptera (containing also the Anoplura and *Hæmatomyzus*) chiefly by their relatively unspecialized mouth-parts, especially in having heavily sclerotized chewing mandibles. It has recently been found that in the genus *Trochilœcetes*, parasitic on the Trochili (hummingbirds), the species have a piercing type of mouth-parts (Fig. 1) instead of the mandibulate mouth-parts typical of the Mallophaga. Although four species of this genus have been described in the last fifty years, no previous reference to their mouth-parts is known.

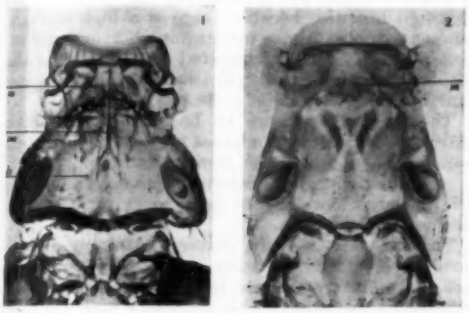


Fig. 1. *Trochilœcetes* sp. × 55 from a hummingbird. *m*, Mandible; *ms*, median structure; *ls*, lateral structure. (Photo. by H. M. Malies)

Fig. 2. *Ricinus* sp. × 47 from a passerine. (Photo. by H. M. Malies)

These structures, which will be fully described and discussed elsewhere, comprise a number of elongated extrusible parts and the modified mandibles. There are three closely associated stylet-like structures, almost certainly of hypopharyngeal origin, which are joined by a common membrane, only the distal tips being free. The median structure (Fig. 1, *ms*) which originates from a sclerotized plate (probably the sitophore sclerite) is heavily sclerotized, and gives rise on each side to a flattened lobe, apparently homologous with the hypopharyngeal lobes characteristic of other Mallophaga. A pair of lightly sclerotized lateral structures have their proximal ends (*ls*) lying lateral and ventral to the sitophore sclerite and seem to represent the modified lingual sclerites. Two flattened elongated outgrowths from the dorsal wall of the distal end of the pre-oral cavity may act as a groove to hold and guide the hypopharyngeal parts. The sclerotized outgrowth of the clypeal wall of the pre-oral cavity (the 'pestle' of the Psocoidea), found in the majority of the Mallophaga, is present in these species. The lacinia are of the typical form found in the Mallophaga, but are distally more elongated and lightly sclerotized. The mandibles (*m*) are lightly sclerotized and the piercing blades lie parallel to the median structure; the end of the left mandible has a minute tooth, the right is sharply pointed. In a related genus *Ricinus* (found on the Trochili and the Passeriformes) the species on the Trochili have also lost the typical Mallophagan mouth-parts, but the modifications both of the mandibles and the hypopharynx are not so extensive. However, in normal *Ricinus* species—which probably also feed entirely on blood—some modification of the mandibles has already taken place (Fig. 2, *m*), these structures being less heavily sclerotized and toothed, and more elongated and pointed than those of other Amblycera which feed on feather parts. The *Ricinus* species on the Trochili are typical of the genus apart from the modified mouth-parts, and this modification, therefore, must have taken place in the *Ricinus* species of the Trochili after the morphological characters of the genus *Ricinus* had been established; *Trochilœcetes*, closely related to *Ricinus* and restricted to the Trochili, must be a later derivative from a *Ricinus*-like ancestor.

Modification from chewing to piercing mouth-parts is now known to have taken place twice in the Phthiraptera, once in the stock which gave rise to the Anoplura or sucking lice of mammals, and, as here described, in the superfamily Amblycera of the Mallophaga. A recent classification[1] divides the Phthiraptera into three suborders: the Mallophaga with chewing mouth parts; the Rhynchophthirina containing only the genus *Hæmatomyzus*, with mandibulate mouth-parts borne at the end of an elongated proboscis; and the Anoplura with highly modified piercing mouth-parts. Recent authors (Webb[2] and Hopkins[3]) have suggested that the Anoplura—in spite of considerable morphological differences, especially those of the mouth-parts—are closely related to the Mallophaga; possibly being derived from an ancestral Ischnoceran stock on a mammal after the mammal-Ischnocera had separated from the bird-Ischnocera. The position of the highly modified elephant louse is still uncertain: it has been placed near the Mallophaga[4] mainly on the possession of mandibulate mouth-parts, and also near the Anoplura[3]. The present description of chewing and piercing mouth-parts within a group of closely related species in the Mallophaga suggests that these structures tend to be plastic, and are not important characters in showing the phylogenetic relationships of the higher categories within the order.

THERESA CLAY

Department of Entomology,
British Museum (Natural History),
London, S.W.7.
April 27.

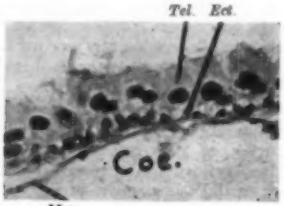
[1] Weber, H., *Biol. Zbl.*, **59**, 409 (1939).
[2] Webb, J. E., *Proc. Zool. Soc. Lond.*, **116**, 49 (1946).
[3] Hopkins, G. H. E., *Proc. Zool. Soc. Lond.*, **119**, 389 (1949).
[4] Ferris, G. F., *Parasitol.*, **23**, 112 (1931).

Modification of the Ectoderm in *Sphenodon*

IN a recent publication[1], attention has been directed to the occurrence of a peculiar modification of the outer layer of the ectoderm of the chorion (and choriogenous ectoderm) of *Sphenodon* (Reptilia, Rhynchocephalia) to produce very large cells with well-marked boundaries, domed free edges and large nuclei. These modified cells show particularly clearly in preparations stained with borax carmine, in which the cells tend to assume a characteristic yellow–orange colour. These cells were first observed by Dendy[2] and Schauinsland[3], who were working independently on the embryology of *Sphenodon*. They applied the term 'teloderm' to the tissue, a term previously used by Mehnert[4] to describe tissue to which the term 'epitrichial layer' more properly applies[5].

Teloderm, of the type found in *Sphenodon*, has not been described as occurring in any other reptile and was thought to be characteristic of *Sphenodon*.

However, during a recent visit to Utrecht (Holland), I was allowed to examine the extensive collection of slides belonging to the Hubrecht Laboratory, and observed a modification of the chorionic ectoderm of *Lacerta agilis* similar to the teloderm of *Sphenodon*. In *Lacerta*, as in *Sphenodon*, these cells are very large, roughly columnar, with well-marked boundaries and domed free edges. The characteristic colour of teloderm when stained with borax carmine is less evident, probably because the sections are rather thinner than those of *Sphenodon* in the Dendy collection (King's College, London), and also probably because of a different staining technique, though the sections appear to be stained with borax carmine. Teloderm in *Sphenodon* always overlies immediately another ectodermal layer, in which the cells are ill-defined, more or less cubical and often distinguished only with the greatest difficulty. In *Lacerta agilis* these underlying ectodermal cells of the chorion are much more evident.



Section through the chorion of *Lacerta agilis*. × 350. *Tel.*, teloderm; *ect.*, underlying ectoderm; *mes.*, somatic mesoderm; *coe.*, extra-embryonal cœlom between chorion and amnion

I wish to express my gratitude to Prof. Raven and Dr. P. D. Nieuwkoop of the Hubrecht Laboratory, Utrecht, and to Prof. D. Mackinnon of the Zoology Department, King's College, London. The photomicrograph was prepared by Mr. Green, of the Zoology Department, King's College, London.

ALAN FISK

Biology Department,
St. Mary's Hospital
Medical School,
London, W.2.
May 3.

[1] Fisk, A., and Tribe, M., *Proc. Zool. Soc. Lond.*, **119**, Pt. 1 (1949).
[2] Dendy, A., *Quart. J. Microscop. Sci.*, **42**, 1 (1899).
[3] Schauinsland, H., *Anat. Anz.*, **15** (1899).
[4] Mehnert, E., *Morph. Arb.*, **4** (1895).
[5] Kerbert, C., *Arch. mikro. Anat.*, **13** (1876).

Natural Epizootics of *Polystoma integerrimum* in Tadpoles

THE life-history of the monogenetic Trematode, *Polystoma integerrimum*, has been studied experimentally by Zeller[1,2] and by Gallien[3]. Both made some field observations, but no full investigations of natural epizootics appear to have been made. A quantitative study of about a thousand tadpoles, with about four thousand parasites, in seven epizootics has now been made, in which the course of the epizootics has been followed through the various stages. The experimental observations have been broadly confirmed, but the events in Nature do show certain differences, and some new facts have been found.

Wide differences exist between the epizootics, but a general plan can be seen in all. The eggs laid by the adult fluke hatch at two main periods, one at the end of April or beginning of May, and the second about a month later. Some of the larvæ which hatch from these eggs (the primary larvæ) become neotenic larvæ, which lay eggs hatching in July (secondary larvæ).

In some ponds, all tadpoles metamorphose in June. The neotenic cycle in these ponds is therefore abortive, because by the time the secondary larvæ hatch there are no tadpoles. Infestation is secured in these ponds by the presence of primary larvæ, particularly those of the second brood. In other ponds, many tadpoles can be found in July or August, and they become infested with the secondary larvæ, even if they have been almost free from the parasites up to that date.

There are large losses of parasites from the gill chamber throughout the season. It seems important for the parasites that some should enter the tadpoles as near to the date of metamorphosis as possible, not only because the gill chamber is not a very safe location, but also because there is a high mortality among tadpoles. Late infestation short-circuits tadpole mortality. It is suggested that late infestation rather than mere multiplication may be the chief function of the neotenic cycle.

The parasite appears to be without deleterious effect upon its host. Tadpoles are just as large when parasitized as when free from infestation.

At the early stages of infestation there is a tendency for the larger tadpoles to have more parasites than the smaller ones.

Tadpoles are not, in Nature, normally infested until well after the stage when they still have external gills. Only one tadpole was found to be infested at this stage. This contrasts with the work of Gallien, who found in laboratory experiments that tadpoles infested after this stage did not afterwards contain neotenics. It was necessary to take younger tadpoles in order that some of the larvæ should develop in this way.

The parasites are not distributed among the tadpoles at random. There is a tendency for a tadpole to be either more heavily infested than statistical considerations would suggest, or else less heavily infested, the intermediate numbers being relatively rare.

A full account of the observations will be published elsewhere.

R. MAXWELL SAVAGE

"Rosenlaui", Parkgate Crescent,
Hadley Wood, Barnet, Herts.
May 5.

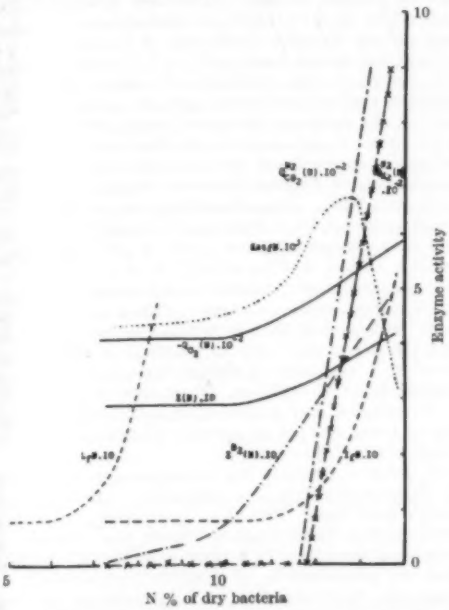
[1] Zeller, E., *Z. wiss. Zool.*, **22**, 1 (1872).
[2] Zeller, E., *Z. wiss. Zool.*, **27**, 238 (1876).
[3] Gallien, L., Trav. Stat. Zool. Wimereux, **12** (1935).

Enzyme Activity and Nitrogen Content of *E. coli*

FEW investigations on protein-poor micro-organisms have been reported so far. It is the purpose of the present paper to summarize results of investigations concerning the enzymatic equipment of bacteria in increasing nitrogen deficiency. *Escherichia coli* was cultured in synthetic media containing saccharose, dipotassium hydrogen phosphate, sodium chloride, magnesium sulphate and ammonium sulphate. The concentration of the latter varies from 1,600 to 6 mgm. per litre nutrient solution. The protein content of the cells varies with the nitrogen content of the culture media: when the concentration of ammonium sulphate is reduced below 200–400 mgm. per litre, a

considerable decrease begins to occur in the protein content of the cells: from about 85 per cent of the dry matter to about 42 per cent in extreme nitrogen deficiency (as calculated from Kjeldahl-nitrogen: from about 13·5 per cent to about 6·5 per cent of dry matter).

We have examined the enzyme activity with increasing nitrogen deficiency. The enzymes investigated were constitutive (catalase), semi-adaptive (saccharase) and adaptive (lactase) enzymes; initial and terminal reactions of intermediate metabolism (hydrolases and 'formic hydrogenlyase'); the respiration enzymes (respiration on different substrates during carbohydrate metabolism) and fermentation (fermentation on glucose).



Enzyme activity and nitrogen content of *E. coli*. L_fN is determined with bacteria cultured on lactose, all the other activities with bacteria cultured on saccharose. L_fN and I_fN are determined with autolysed, the other enzyme activities with resting, bacteria. L_fN, I_fN and Kat_fN: activities of lactase, saccharase and catalase per gm. nitrogen. Q values: uptake or formation of gases from glucose in mm.³/hour/mgm. nitrogen. $Z(N)$: acid formation in air from glucose expressed as ml. $N/10$ sodium hydroxide/hour/mgm. nitrogen. $Z^{N_2}(N)$: acid formation in air from glucose expressed as ml. in atmosphere of nitrogen

The following results have been obtained (see also the accompanying graph):

(1) The saccharase activity (I_fN) of the cells diminishes abruptly when the protein content of the cells decreases. In cells with very low protein content the saccharase activity is still 10–20 per cent of its normal value[1].

(2) In initial nitrogen deficiency (14–12·5 per cent nitrogen) there is, on the contrary, an increase in the catalase activity (Kat_fN) which is difficult to explain. When the nitrogen content of the cells falls below 12·5 per cent there is a decrease of Kat_fN; the latter is stabilized in extreme nitrogen deficiency at a value slightly higher than the value obtained with normal cells[1].

(3) These results[1] corroborate the hypothesis of Virtanen[2], who considers the cell proteins as consisting chiefly of enzyme proteins. It is deduced from the experiments reported in this communication that the enzyme proteins constitute probably at least half the bacterial proteins.

The completely adaptive lactase behaves exactly as saccharase: 10–20 per cent of its normal activity (L_fN) is preserved, even in cells very low in nitrogen.

It follows from the above that not only the constitutive and adaptive properties are important for the behaviour of enzymes during nitrogen deficiency: only the part of the adaptive hydrolases involved in the energy-liberating reactions of the cell is preserved. Calculation shows that this amount of adaptive hydrolases, still present in the very low-nitrogen cell, suffices to form substrates for a further normal breakdown.

The enzymes which catalyse the energy-liberating reactions are preserved in the low-nitrogen cell[3]. The respiration-rate ($Q_{O_2}(N)$) of a substrate for carbohydrate metabolism is 30 per cent slower for low-nitrogen cells than for normal cells. The respiration-rate of bacteria with extremely low protein content (4 per cent nitrogen, cultured on lactose synthetic media) is only 40–60 per cent of the normal values. The substrates investigated were: saccharose, lactose, glucose, fructose, succinate, glycerate and pyruvate. The respiration-rate of all these substances diminishes in the same way in nitrogen deficiency. It is deduced from these results that the enzymes cytochrome, cytochrome oxidase(s) and perhaps diaphorases are preserved. The decrease of 30 per cent in the respiration-rate is attributed to the diminution of the adaptive apodehydrogenases.

The adaptive enzymes which catalyse the formation of hydrogen and bicarbonate from formate disappear completely in nitrogen deficiency (curve $Q_{H_2}^{N_2}(N)$). Cells which have lost 20 per cent of their protein content are completely devoid of 'formic hydrogenlyase'. This is attributed to the fact that the decomposition of formate consumes energy[4].

Carbon dioxide formation disappears likewise in low-nitrogen *coli* ($Q_{CO_2}^{N_2}(N)$).

Low-nitrogen *coli* have lost the ability to produce acids from glucose in anaerobiosis ($Z^{N_2}(N)$). Anaerobic acid formation is similar to that of adaptive enzymes. On the other hand, in aerobiosis, acids are formed from glucose, even by very low-nitrogen *coli* ($Z(N)$); the aerobic acid formation is parallel to the respiration-rate curve. Hence it follows that low-nitrogen *coli* carry out a slightly decreased respiration but no fermentation of glucose.

In low-nitrogen *coli* the respiration is not a continuation of the fermentation. The above results are not in contradiction with the theory that the respiration of glucose proceeds via triosephosphate dehydrogenase; other possibilities, however, such as respiration by way of phosphogluconic acid, gluconic acid or a non-phosphorylating mechanism, might explain equally well the results described above.

These experiments enable us to put forward a hypothesis of the chronological formation of enzymes during the growth of a daughter bacterial cell on a mother cell. During growth of the daughter cell the enzymes first formed are those which still exist in low-protein cells. Indeed, a normal cell contains about 80 per cent proteins of its dry matter, a low-nitrogen cell about 40 per cent. Just after division, the daughter cell contains as much protein as the low-nitrogen cell, but its enzymatic equipment, however, is quite different; the former contains, roughly speaking, about 60 per cent of enzymes such as cytochromes, cytochrome oxidase(s), diaphorases (?),

constitutive enzymes such as catalase, a minimal amount of hydrolases, and probably a group of phosphorylating enzymes, calculated on proteins, whereas the latter contains about 100 per cent. A daughter cell, growing in nitrogen-deficient media, can only develop into a low-nitrogen cell when these energy-providing enzymes are first formed, whether by transformation of other enzymes into them or because their rate of formation from ammonium ions is greater than that of the other enzymes. This should also happen in normal cells, but in this instance the source of nitrogen is not exhausted, and the enzymes normally present are formed afterwards.

A full account of this work is to be published elsewhere.

J. De Ley

Biochemical Laboratory,
Veterinary College,
State University,
Ghent.

[1] Virtanen, A. I., and De Ley, J., *Arch. Biochem.*, **16**, 169 (1948).
[2] Virtanen, A. I., *Suomen Kemistilehti*, B, **15**, 22 (1942).
[3] De Ley, J., *Arch. Biochem.*, **20**, 251 (1949).
[4] Woods, D., *Biochem. J.*, **30**, 515 (1936).

Mechanism of Propionic Acid Formation in Bacterial Fermentation

In the course of a study of the microflora of the rumen of sheep, an interesting anaerobic micrococcus was isolated from lactate enrichment cultures. It failed to ferment sugars but produced acetic and propionic acids, carbon dioxide and hydrogen from lactate and pyruvate. It was shown to be similar to *Veillonella gazogenes* obtained from Dr. A. R. Prevot of the Pasteur Institute, and to *Micrococcus lactilyticus* supplied by Dr. E. Foubert, jun.[1].

This micrococcus was found to be indigenous in the mouth of man, rabbit and sheep and was present in the rumen of all sheep tested. The metabolism of this organism was studied in the hope of determining the mechanism of propionic acid formation from pyruvate.

Barker and Lipmann[2], in following up fluoride-inhibition studies with *Propionibacteria* by Chaix Audenard, eliminated the possibility of propionic acid arising by the direct reduction of pyruvate and lactate in this genus. Werkman and Wood[3] considered the possibility of decarboxylation of succinic acid as a major pathway for the formation of propionic acid, and though they obtained indirect evidence from isotope studies that a symmetrical dicarboxylic acid was involved, they did not publish results showing a convincing conversion of succinic acid to propionic acid and carbon dioxide. Krebs and Eggleston[4] demonstrated that the series of reactions, shown below, from oxalacetate to succinate were reversible in the Propionibacteria, but could not demonstrate any decarboxylation of succinate.

$$\text{Pyruvate} \rightleftharpoons \text{oxalacetate} \overset{CO_2}{\rightleftharpoons} \textit{l}\text{-malate} \rightleftharpoons \text{fumarate} \rightleftharpoons \text{succinate propionate-}CO_2. \quad (1)$$

In studies with *Veillonella*, experimental evidence, as given below, indicates that this scheme represents the mechanism for the production of propionic acid.

(1) Under anaerobic conditions, washed suspensions of bacteria grown on lactate as the source of carbon attacked pyruvate, oxalacetate, *l*-malate and fumarate with the production of propionic and acetic acids, hydrogen and carbon dioxide, but *d*-tartrate was not fermented. (2) Bacteria grown on *d*-tartrate fermented it in washed suspensions with the formation of propionic and acetic acids, carbon dioxide and hydrogen. This indicated that the enzymes attacking substrates in (1) are constitutive while that fermenting *d*-tartrate was adaptive. (3) Succinic acid was quantitatively decarboxylated to propionic acid and carbon dioxide. The *p*H optimum for this reaction was 5·9–6·0 with a Q_{CO_2} of 270–300 (not *p*H 7·4 as reported previously[3]). (4) The amount of propionic acid produced from lactate as substrate was shown in both washed suspensions and growth experiments to be dependent on the carbon dioxide concentration. The ratio propionic : acetic varied from 1 : 1 with no carbon dioxide present (absorbed with potassium hydroxide) to 2 : 1 with an atmosphere of 100 per cent carbon dioxide. Both sets of experiments were carried out at the same *p*H. (5) When *Veillonella* was grown in the presence of carbon-13 dioxide, added as sodium carbonate, isotopic carbon was fixed only in the carboxyl group of propionic acid.

In view of the results obtained with *Veillonella gazogenes*, experiments were carried out with washed suspensions of Propionibacteria obtained from Prof. C. B. van Niel. Using Warburg manometers, it was found, as stated by Werkman and Wood[3], that succinic acid was decarboxylated with a *p*H optimum of 5·0–5·2. There was no activity at 6·8. The Q_{CO_2} for the reaction varied with the strain used. With 5-day old cultures grown on lactate, the Q_{CO_2} for *P. shermanii* strain *E*.11·1 was 0·48, whereas for *P. Zeæ* strain *E*.8·1 it was 1·0. So long as the *p*H remained above 6·5, the rate of decarboxylation was not increased by the addition of glucose as was claimed by Fromageot and Bost[4]. The only effect of glucose was to lower the *p*H as a result of its fermentation to propionic and acetic acids.

In order to identify the end-products of the attack of Propionibacteria on succinate, growth experiments were used. The Q_{CO_2} (succinate) was too low with washed suspensions to obtain a reasonable conversion of succinate in a time short enough to ensure that no proliferation of possible contaminants had occurred. Growth of Propionibacteria on glucose + succinate showed a quantitative conversion of the succinate to propionate and carbon dioxide when compared with a control grown on glucose. Succinate was decarboxylated only if the *p*H of the medium fell below 6·5 during the fermentation. With lactate as the source of carbon, there is no change of acidity during the fermentation, and with an initial *p*H of 7 added succinate was not attacked.

The variation in the ratio propionic to acetic acid found with Propionibacteria fermentations by many investigators has not been satisfactorily explained. Wood and Werkman[7] obtained ratios as high as 14·72 : 1 compared with the theoretical value of 2 : 1 for the fermentation of glucose.

$$3C_6H_{12}O_6 \rightarrow 4C_2H_5COOH + 2CH_3COOH + 2CO_2 + 2H_2O. \quad (2)$$

In the present work it was found that provided the *p*H fell sufficiently during the fermentation to allow the succinic acid formed to be decarboxylated, the ratio of propionic to acetic acid was dependent on the carbon dioxide concentration in the medium.

It was not found possible to obtain a cell-free extract of either *Veillonella* or Propionibacteria which would decarboxylate succinic acid. Propionibacteria, dried according to the method of Barker and Lip-

mann[2], were found to be active in decarboxylating succinate.

The results given above, taken together with those of Werkman and Wood[3], and Krebs and Eggleston[4], indicate that the scheme (1) represents the major pathway in propionic acid formation with both Propionibacteria and *Veillonella*.

Since completion of this work[5], Delwiche[9] has published results of studies on *P. pentosaceum* and reports a considerably higher Q_{CO_2} (succinate) of 4·4 using 36-hr. cultures. He found that 0·3 *M* malonate inhibited propionate production from pyruvate, which is added proof that the step fumarate – succinate is involved.

The mechanism of the conversion of propionate to carbohydrate in the animal body is unknown. This source of carbohydrate is of considerable importance to ruminants, which produce propionate by bacterial action in the rumen and absorb it from that organ[10]. It is possible that a reversal of the steps from pyruvate to propionate could occur, involving fixation of carbon dioxide in the methyl group of propionic acid to produce succinic acid. In fact, the results of Wood[11], on the distribution of carbon-13 in the glucose unit of glycogen obtained by feeding propionic acid labelled with carbon-13 to rats, find their simplest interpretation in this scheme. This involves the postulation of an entirely new type of carbon dioxide fixation reaction.

A full account of this work will be published elsewhere. I am grateful for the encouragement and help given by the late Dr. M. Stephenson, Dr. S. R. Elsden and Dr. E. F. Gale, and wish to express my thanks to those who supplied cultures.

A. T. Johns*

Department of Biochemistry and
Agricultural Research Council
Unit of Animal Physiology,
Cambridge.

* Present address: Plant Chemistry Laboratory, Palmerston North, New Zealand.

[1] Foubert, Jun., E. L., and Douglas, H. C., *J. Bact.*, **56**, 35 (1948).
[2] Barker, H. A., and Lipmann, F., *Arch. Biochem.*, **4**, 361 (1944).
[3] Werkman, C. H., and Wood, H. G., "Adv. in Enzymol.", **2**, 135 (1942).
[4] Krebs, H. A., and Eggleston, L. V., *Biochem. J.*, **35**, 676 (1941).
[5] Johns, A. T., *Biochem. J.*, **42**, *Proc.*, ii (1948).
[6] Fromageot and Bost, *Enzymologia*, **2**, 225 (1938).
[7] Wood, H. G., and Werkman, C. H., *Biochem. J.*, **30**, 48, 618 (1936).
[8] Johns, A. T., Ph.D. Thesis, University of Cambridge (1948).
[9] Delwiche, E. A., *J. Bact.*, **56**, 811 (1948).
[10] Elsden, S. R., and Phillipson, A. T., *Ann. Rev. Biochem.*, **17**, 705 (1948).
[11] Wood, H. G., "Isotopes in Biology and Medicine", 233 (University of Wisconsin Press, 1948).

Inositol and Phosphorylation of Liver Lipids

The lipotropic actions in the liver of inositol and choline are well established. The action of choline on liver lipids has been related to phospholipid metabolism; there is no explanation of the lipotropic effect of inositol, although Handler[1] has suggested that inositol may act as a catalyst in phosphorylation. When choline and inositol are administered to rats on certain diets, the reduction in concentration of liver lipid is greater than if either is given singly[1,2]. This might be due to an effect of inositol on the choline-containing phospholipid of the liver, or to the existence of an alternative path of fat metabolism involving inositol. We have investigated the effect of injected inositol on liver phospholipid synthesis.

Male albino rats (120–150 gm.) of the Wistar strain were fed for eight days on a diet of 8 per cent casein, 77 per cent sucrose, 5 per cent dried yeast, 5 per cent salt mixture and 5 per cent cellulose powder. The rats were arranged in three groups of litter-mates and starved for four hours. One group received 1·0 ml. of pure oleic acid per rat by stomach pump, followed by 50 mgm. of meso-inositol in 1·5 ml. water by intraperitoneal injection. The second group received oleic acid only. The control group received neither oleic acid nor inositol. Oleic acid was given to increase the level of fat metabolism and was chosen in preference to natural oils for several reasons; for example, corn oil has been shown to obliterate the lipotropic action of inositol[2,3]. All rats were injected intraperitoneally with 10 μc. of phosphorus-32 as sodium dihydrogen phosphate in 0·5 ml. water. All injections were given at the same time and the rats killed six hours later.

In the tables below, 'total phospholipid' represents phospholipid extracted by cold alcohol and ether, and therefore does not necessarily include all the liver inositol-containing phospholipid. The choline-containing phospholipids were separated with magnesium oxide[4].

Treatment	No. of rats	Relative activity* of liver total phospholipid	Relative activity of liver choline-containing phospholipid
Controls	7	49·7 S.E. 2·79	50·21 S.E. 3·62
Oleic acid	7	50·2 S.E. 2·47	51·96 S.E. 3·35
Oleic acid +inositol	7	40·4 S.E. 3·21	41·31 S.E. 3·04

* Relative activity = % injected P^{32} per mgm. phospholipid phosphorus × 100 ÷ % P^{32} per mgm. of inorganic phosphate phosphorus.

Statistical comparison of phospholipid relative activities

Treatments compared	Phospholipid fraction	t	n	P
Oleic acid +inositol —— Oleic acid	Total	2·52	12	0·030
Oleic acid +inositol —— Controls	,,	2·18	12	0·050
Oleic acid +inositol —— Oleic acid and controls	,,	2·80	19	0·010
Oleic acid +inositol —— Oleic acid	Choline-containing	2·35	12	0·039
Oleic acid +inositol —— Controls	,, ,,	1·88	12	0·088
Oleic acid +inositol —— Oleic acid and controls	,, ,,	2·43	19	0·027

Statistical methods and symbols are those used by Fisher[4].

The average values of the percentage of injected phosphorus-32 per mgm. of phosphorus of the liver inorganic phosphate and the total and choline-containing phospholipids did not differ significantly among the groups. There were no significant differences in concentrations of total lipid, amounts of total phospholipid, and percentage of choline-containing phospholipid (62–67 per cent) in any of the groups. The relative activity of the total and choline-containing phospholipid was, however, significantly reduced in the group receiving inositol.

These results suggest that injection of inositol together with administration of oleic acid reduces the rate at which phosphorus is incorporated into both choline-containing and non-choline-containing phospholipids. A single injection of inositol may not have the same effect on phospholipid synthesis as administration of smaller doses over a period of several days; nevertheless, the results reported here do not support the view that inositol exerts its lipotropic action by stimulating the turnover of the choline-containing or non-choline-containing phospholipids extracted with cold alcohol–ether.

There is evidence from work on kidney metabolism of an effect of inositol on phospholipids. Thus Handler[6] has found that administration of inositol to rats fed lipogenic diets increases the incidence and severity of renal hæmorrhages, while Patterson, Keevil and McHenry[7] have obtained evidence which may indicate that increased turnover of kidney phospholipid accompanies reduction of these hæmorrhages.

We would like to thank Prof. B. S. Platt for his interest in this work.

M. Blewett
I. G. Campbell
June Olley

Human Nutrition Research Unit,
Medical Research Council,
National Hospital, Queen Square,
London, W.C.1.
March 31.

[1] Handler, P., *J. Biol. Chem.*, **162**, 77 (1946).
[2] Forbes, J. C., *Proc. Soc. Exp. Biol. and Med.*, **54**, 89 (1943).
[3] Beveridge, J. M. R., and Lucas, C. C., *J. Biol. Chem.*, **167**, 319 (1945).
[4] Taurog, A., Entenman, C., Fries, B. A., and Chaikoff, I. L., *J. Biol. Chem.*, **155**, 19 (1944).
[5] Fisher, R. A., "Statistical Methods for Research Workers" (Oliver and Boyd, 1944).
[6] Handler, P., *J. Nutrition*, **31**, 621 (1946).
[7] Patterson, J. M., Keevil, and McHenry, E. W., *J. Biol. Chem.*, **153**, 489 (1944).

Crystalline Derivatives of the Polymyxins and the Identification of the Fatty Acid Component

Five antibiotic polypeptides, polymyxins *A*, *B*, *C* and *E* (discovered in these Laboratories[1]) and polymyxin *D* (described by the American Cyanamid Company[2]), and readily differentiated by their amino-acid components and their behaviour on the paper chromatogram[3], have been isolated from the products of the growth of different strains of *B. polymyxa* (*B. aerosporus*).

Research in these Laboratories has been directed chiefly to polymyxins *B* and *E*, both of which have yielded crystalline naphthalene-β-sulphonates, from which, by repeated recrystallization and regeneration, highly active materials have been isolated. The use of naphthalene-β-sulphonic acid has been found to be an essential step in the purification of these polymyxins, and has now been instrumental in the isolation of crystalline polymyxin *B* hydrochloride and crystalline polymyxin *E* neutral sulphate.

Following a private communication from the American Cyanamid Company that acid hydrolysis of polymyxin *D* liberated a fatty acid isomeric with pelargonic acid, it was found that acid hydrolysis of all polymyxins yielded an optically active fatty acid, $C_9H_{18}O_2$, identical in each case and readily characterized as the amide and *p*-bromobenzylthiuronium salt[4]. The constitution of the acid has now been determined as *d*-6-methyloctan-1-oic acid (I). Degradation of the methyl ester according to the scheme represented below gave *d*-3-methylpentan-1-oic acid (II), identified by comparison of the melting points of the amide and *p*-bromobenzylthiuronium salt with authentic samples derived from the synthetic acid obtained by resolution of the quinine salt of the racemic 3-methylpentan-1-oic acid.

An absolute proof of the identity is now being sought by the synthesis of *d*-6-methyloctan-1-oic acid (I). Full details will be reported elsewhere.

S. Wilkinson

Chemical Division,
Wellcome Research Laboratories,
Beckenham, Kent.
April 19.

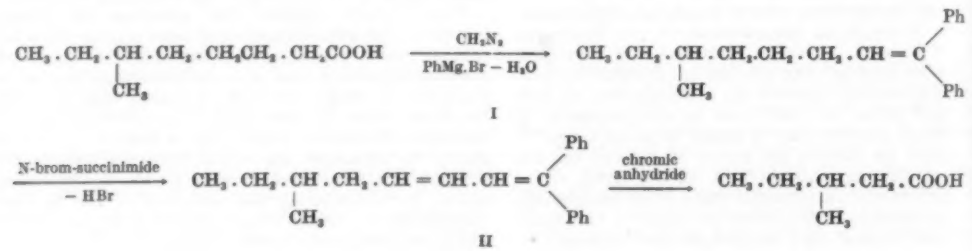
[1] Brownlee, G., and Jones, T. S. G., *Biochem. J.*, **43**, xxv (1948).
[2] Stansly, P. G., Shepherd, R. G., and White, H. J., *Bull. Johns Hop. Hosp.*, **81**, 43 (1947).
[3] Jones, T. S. G., *Biochem. J.*, **43**, xxvi (1948).
[4] Catch, J. R., Jones, T. S. G., and Wilkinson, S., *Ann. N.Y. Acad. Sci.*, **51**, 917 (1949).

Crystallizable Recombined Hæm–Globin from Human Red-Cell Hæmoglobin

The preparation of globin from hæmoglobin by removal of the hæm with acid has long been known[1], but it has become increasingly clear that such globin preparations, when recombined with hæm, give a product differing from the original hæmoglobin in some properties such as spectral absorption[2] and solubility. Gralén showed[3] that although in the ultracentrifuge recombined hæm–globin gave results similar to those of the original horse hæmoglobin, electrophoresis showed up differences.

We have prepared from human red-cell hæmoglobin a globin which will recombine spontaneously with hæm to give a product more closely resembling the original hæmoglobin than any so far described, in that spectral absorption differences have been eliminated, its solubility is of the right order, and it can be crystallized in forms normal to human adult hæmoglobin.

We have observed that in globins prepared by the usual methods a prominent spectral absorption band due to tryptophan appears at wave-lengths varying between 289·0 mμ and 290·3 mμ. This band normally appears at 288·0 mμ in free tryptophan in aqueous solution, but is shifted to 291·0 mμ in most proteins, including human adult red-cell hæmoglobin. The wave-length of this band provided a most valuable criterion in following the globin preparation, and for its observation the moving-plate spectrographic method of Holiday[4] proved indispensable. Fractionation of the crude globin solution by 50 per cent saturation with ammonium



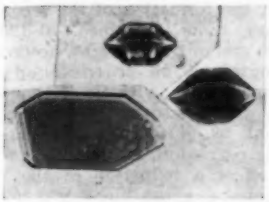


Fig. 1. Crystals of methæmoglobin from recombined hæm–globin (human). (× 100)

sulphate concentrated the longer wave-length absorbing material in solution. By rejecting at each stage all but the material absorbing the longest wave-length (that is, greater than 290·6 mμ), we were able to prepare a globin which yielded a crystallizable recombined hæm–globin. There is a slight increase in wave-length of the tryptophan band to 291·0 mμ on recombination with hæm. Crystallizable recombined hæm–globin from muscle hæmoglobin is apparently obtainable more readily than that from red-cell globins[5], and it is worth noting that the tryptophan band in muscle hæmoglobins is normally observed at 290·0 mμ, shorter than the 291·0 mμ of most proteins[6]. The significance of these shifts in position of the tryptophan band in proteins will be discussed elsewhere[7].

Globins prepared by the usual methods and remaining soluble in neutral solution show the tryptophan band at wave-lengths short of the 290·6–290·8 mμ required by our observations and yet appear to be 'native' according to the criterion of Crammer and Neuberger[8], based on a spectrographic study of the dissociation of the tyrosine phenolic hydroxyl group. It thus appears possible to separate the process of denaturation into several stages, which is also shown by a study of the Soret absorption band of oxyhæmoglobin[6].

In the present work the hæm was removed from carboxyhæmoglobin in a large volume of acetone–hydrochloric acid mixture (about 1·5 per cent acid) cooled to − 15° C. (Anson and Mirsky[1], modified). The precipitated globin was washed free from pigment with chilled acetone to which barium carbonate was added in the later stages. A 15 per cent aqueous solution of this globin was dialysed against *M*/30 dipotassium hydrogen phosphate, precipitated material being separated by filtration in the refrigerator. The supernatant solution was brought to half-saturation with ammonium sulphate, and any precipitated material again removed by filtration. Such preparations showed a tryptophan band at 290·6–290·7 mμ. Hæmin in *N*/10 sodium hydroxide was added to the globin solution (1 mol hæmin to 1 equivalent of globin, equiv. weight taken as 17,000), and recombination to methæmoglobin occurred spontaneously.

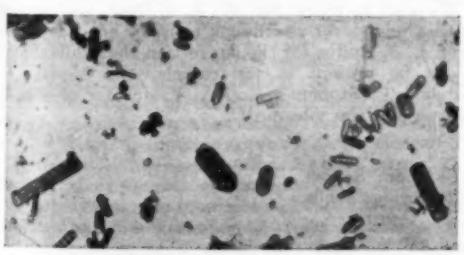


Fig. 2. Crystals of reduced hæmoglobin from recombined hæm–globin (human). (× 100)

This recombined methæmoglobin was crystallized by dialysis against 2·8 *M* phosphate (*p*H 6·8), yielding octahedra (Fig. 1) belonging to the orthorhombic system, identical with those normally obtained from human adult methæmoglobin[9]. These methæmoglobin crystals dissolved in water and were reduced with sodium hydrosulphite, and the resulting reduced hæmoglobin was crystallized from 2·8 *M* phosphate (*p*H 6·8) as rectangular prisms (Fig. 2), apparently identical with those obtainable from normal human adult reduced hæmoglobin[9].

The recombined reduced hæmoglobin was converted to carboxy- and oxyhæmoglobin with carbon monoxide and oxygen respectively, and the spectral absorption bands of all these recombined products were observed at the wave-lengths usual for such derivatives of normal human adult hæmoglobin (see table).

Wave-lengths of ultra-violet spectral absorption bands of hæmoglobins and recombined hæm–globins

Hæmoglobin	Tryptophan band (mμ)	Soret bands, mμ MetHb	Hb	HbCO	HbO_2
Normal human adult red-cell hæmoglobin	291·0	405·5	425	419·5	414·5
Recombined hæm–globin (present work)	291·0	405·5	424	419·5	414·0
Recombined hæm–globin from usual globin preparations	289·8 to 290·6	405·5	—	416·0	411

The above results show that it is possible to obtain a globin from human red-cell hæmoglobin which will recombine spontaneously with hæm to give a product so closely resembling the original hæmoglobin as to suggest that the hæm–globin linkages are identical in the two cases. This makes it at least *possible* that hæmoglobin could be formed in the developing red blood cell by addition of completely formed hæm groups to the surfaces of pre-formed globin molecules[10], though this is not necessarily the process involved.

We wish to thank Prof. C. Rimington, Dr. H. F. Holden and Dr. E. R. Holiday for helpful discussions, and the Medical Research Council for supporting this work.

E. M. Jope

Spectrographic Laboratory,
The London Hospital, E.1.

H. M. Jope
J. R. P. O'Brien

Department of Biochemistry,
Oxford. April 21.

[1] Schulz, F. N., *Z. Physiol. Chem.*, **24**, 449 (1898). Hill, R., and Holden, H. F., *Biochem. J.*, **20**, 1326 (1926). Anson, M. L., and Mirsky, A. E., *J. Gen. Physiol.*, **13**, 469 (1930).

[2] Wyman, J., "Advances in Protein Chemistry", **4**, 454 (1948). Jope, E. M., in "Hæmoglobin", papers presented at the Sir Joseph Barcroft Memorial Conference, Cambridge, 1948, p. 218 (London, 1949). Jope, E. M., quoted in Rimington, C., and Fulton, J. D., *Biochem. J.*, **41**, 619 (1947).

[3] Gralén, N., *Biochem. J.*, **33**, 1907 (1939). It may be noted that free globins appear to have molecular weights of the order 34,000, half that of the red cell hæmoglobins.

[4] Holiday, E. R., *J. Sci. Instr.*, **14**, 166 (1937); a more recent account is in the press.

[5] Drabkin, D. L., *J. Biol. Chem.*, **158**, 721 (1945).

[6] Jope, E. M., in "Hæmoglobin", papers presented at the Sir Joseph Barcroft Memorial Conference, Cambridge, 1948, p. 216 (London, 1949).

[7] Holiday, E. R., and Jope, E. M. (to be published).

[8] Crammer, J. L., and Neuberger, A., *Biochem. J.*, **37**, 302 (1945).

[9] Perutz, M. F., and Weiss, O., *Nature*, **160**, 786 (1947). Jope, H. M., and O'Brien, J. R. P., in "Hæmoglobin", papers presented at the Sir Joseph Barcroft Memorial Conference, Cambridge, 1948, p. 269 (London, 1949).

[10] Compare Thorell, B., *Acta med. Scand., Supp.*, **200**, 89 (1947). Dacie, J. V., and White, J. C., *J. Clin. Path.*, **2**, 21 (1949).

Formation and Distribution of Vitamin C in the Radicle and Cotyledon of the Broad Bean (*Vicia faba*)

During an investigation on the quantity of vitamin C in the broad bean, it was observed that the dry bean contained a high quantity of the vitamin. The figures obtained were between 9 mgm. and 11 mgm. of vitamin C per 100 gm. of fresh weight, and there was a rapid increase when the beans were soaked in water. The various parts of the bean were assayed for the vitamin and it was found that the cotyledons contained 3–4 mgm./100 gm. of fresh weight, and the amount rose to a maximum of 40–50 mgm. before falling off on the ninth day. At the same time the amount of the vitamin in the radicle rose from an average of 10·68 mgm./100 gm. of fresh weight on the first day to an average of 202·16 mgm. on the eighth day, and fell to an average of 11·87 mgm. on the twenty-fifth day, at which time the seedling was well established with plumule leaves and secondary roots. Care was taken to see that the separate radicles were of equal length when each batch was analysed; the whole of the main root was used without the secondary roots when they appeared. When the radicles had emerged, the seedlings were placed in complete culture solutions contained in Winchester bottles, and the solutions were well aerated.

The vitamin assays were carried with 2.6.dichlorophenolindophenol, the method of extraction and assay being similar to that given by Wokes and Organ[1]. The results of this part of the investigation are shown in Fig. 1. From this graph it may be seen that the line rises smoothly and steeply during the first eight days, and this is followed by a steep curve on the ninth day and a gradual fall to the twenty-fifth day.

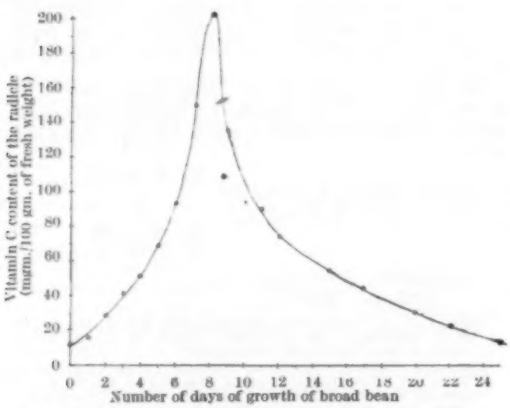


Fig. 1. Variation of the vitamin C content of the radicle with time

The figures for the vitamin content of the cotyledon might be explained on the supposition that the cotyledons are manufacturing the vitamin from stored food materials and passing it to the radicle. The radicle would use the vitamin for its rapid initial stages of growth. Virtanen, v. Hausen and Saastamoinen[2] have stated that vitamin C is a growth hormone, and Virtanen and v. Hausen[3] have recently given further proof of their statement. The fall in the vitamin content of the radicle might be due to one of two reasons: first, the growth of the plumule, and secondly, the formation of the secondary roots. The secondary roots contained 70–120 mgm. of vitamin C/100 gm. of fresh weight, according to their respective lengths.

The extremely high vitamin C content of the radicle might well be suspect. For this reason it was suggested that as glutathione was known to be present in the cotyledon, it might be present in the radicle and effect a reduction of the 2.6.dichlorophenolindophenol. Glutathione was found in the cotyledon, but not in the radicle at any stage of its growth. This does not mean that glutathione is absent from the radicle, because the test used is not quantitative (sodium nitroprusside, ammonium sulphate and strong ammonia), but it does mean that glutathione, if present, is at too low a level to have any appreciable effect on the titrations.

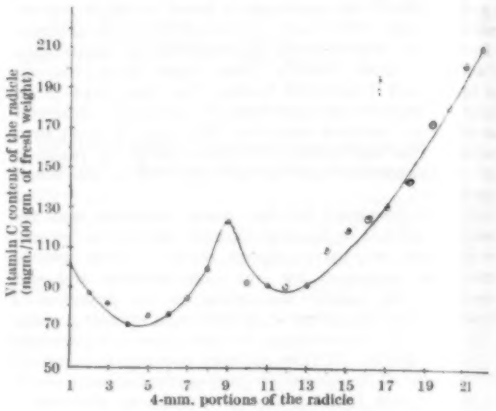


Fig. 2. Variation of the vitamin C content in the different regions of the radicle

As it is known that the vitamin acts as a growth hormone, 4-mm. portions of radicles of equal lengths on the sixth day were analysed for the vitamin. The first portion contained an average of 100·81 mgm. of vitamin C/100 gm. of fresh weight. This value fell to 74·48 mgm. and then gradually rose to 112·96 mgm. in the ninth portion. This was followed by a short decrease to 90·90 mgm. in the thirteenth portion, and a rise to 210·08 mgm. in the twenty-second portion (see Fig. 2).

The 100·97 mgm. would be present in the meristematic region. The first rise occurs in the region of maximum growth. The second rise takes place as one passes up the radicle towards the cotyledon from which the vitamin would be translocated.

We wish to thank Mr. W. R. G. Bye, headmaster of this School, for permission to carry out this work, Prof. L. J. Audus for the suggestion that glutathione might be present in the radicle, and Messrs. R. Tatchell, C. Stoneman and A. V. Jell for assistance in assaying the vitamin C.

A. C. Shaw
L. C. Pascoe

Skinners' School,
Tunbridge Wells.
April 5.

[1] Wokes, F., and Organ, J. G., *Biochem. J.*, **37**, 259 (1943).
[2] Virtanen, v. Hausen and Saastamoinen, *Biochem. Z.*, **267**, 179 (1933).
[3] Virtanen, A. I., and v. Hausen, S. S., *Nature*, **163**, 482 (1949).

Concentration and Distribution of Polysaccharides in Human Cortical Bone and the Dentine of Teeth

THE probable presence of a sulphated polysaccharide in bone has been recognized for many years[1]. Recently, attention has been redirected to the subject by the isolation[2] of a substance claimed to be identical with chondrontin sulphate, which is known to be one of the principal constituents of cartilage[1,3], from dentine of human teeth. As a basis for future work on the organic matrix of bone and teeth it seems to be of importance to know: (1) the order of concentration of the mucopolysaccharides in them; (2) the changes, if any, which take place with age; (3) the distribution of polysaccharide. The present work is a contribution to problems (1) and (3). Insufficient samples have yet been analysed to give an answer to point (2), but the following is a preliminary summary of the results so far obtained.

The samples of bone were obtained during autopsies on accident cases and were taken from a point in the femur well removed from the epiphyseal line. No trabecular bone was present. The samples, about 2 cm. long, were cleaned of marrow, blood and adhering tissues by brushing with detergents, then dried and powdered with a slow running dental bur. The dentine was ground out of cleaned, dried human teeth which had been extracted for various reasons. When carious teeth had to be used, the dentine sample was ground from an area well removed from the lesion. The samples of powder were all extracted for 24 hr. with ether using a Sohxlet extractor and dried *in vacuo* over sulphuric acid.

Composition of human femur with increase in age

Age	No. of samples in group	% dry defatted bone				
		Ca	P	N	Hexosamine	T.R.S.
9–22 mth.	3	20·4–21·7	9·7–10·3	5·01–4·65	0·26–0·20	4·20–3·91
15–31 yr.	4	23·2–25·1	9·8–10·8	4·66–4·23	0·19–0·13	4·34–3·40
47–61 yr.	4	24·9–25·9	9·4–10·7	4·39–4·37	0·14–0·11	4·04–2·06

T.R.S., total reducing substances after acid hydrolysis (estimated as glucose).

The amount of hexosamine and reducing sugars estimated in acid hydrolysed samples of the ether-extracted powders was used as an indication of the concentration of mucopolysaccharides. Hexosamine was measured by the Morgan and Elson[4] technique, and reducing substances by Somogyi's[5] method. Calcium[6] and phosphorus[7] were estimated on ashed samples of bone powder, and total nitrogen was determined on the powders of both dentine and bone.

The accompanying table shows that bone contains about 0·25–0·10 per cent hexosamine (as glucosamine hydrochloride) and 2·06–4·04 per cent reducing substances (as glucose). The few figures so far obtained suggest that there is a tendency for increasing calcification to proceed during the early years of life at the expense of both protein and mucopolysaccharide to about equal extents. The ratio of nitrogen to hexosamine remains approximately constant in comparison with increasing values for calcium and decreasing values for nitrogen and reducing substances for ages between nine months and twenty years. The concentrations of hexosamine and reducing substances in dentine are respectively about 0·10 and 3·5 per cent. These values do not appear to change significantly with age.

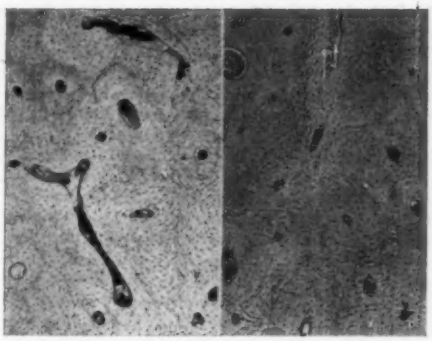


Fig. 1. (*a*) Staining of material in Haversian canals after treatment of ground section of cortical bone with hydroxylamine followed by the Hotchkiss procedure. × 100. (*b*) Section not treated with periodate. × 100

The distribution of the polysaccharides has been examined in both ground and decalcified sections of cortical bone (femur) and human teeth using the Hotchkiss[8] procedure, which involves periodate oxidation followed by treatment with Schiff's reagent. When the unmodified technique is used, considerable red staining occurs in the control sections (that is, not treated with periodate). This reaction is almost completely prevented by preliminary treatment of the sections with a solution of hydroxylamine hydrochloride dissolved in aqueous sodium acetate (private communication from J. F. Danielli). In bone, the red-staining polysaccharide is concentrated almost entirely in the Haversian canals (Fig. 1). A faint uneven staining of the lamellæ and intra-lamellar material occurs, but its significance has not so far been ascertained. In the sections of teeth, the Tomes' fibres within the dentinal tubules stain regularly (Fig. 2), but again there is sometimes an uneven faint staining of the matrix. The matrix did not stain deeply as was reported by Wislocki *et al.*[9], who used the McManus[10] staining procedure, nor were structures in the position of Neumann's sheath stained, as might have been expected from their finding of a metachromatic area around the dentinal tubes after treatment with toluidine blue. Since the McManus

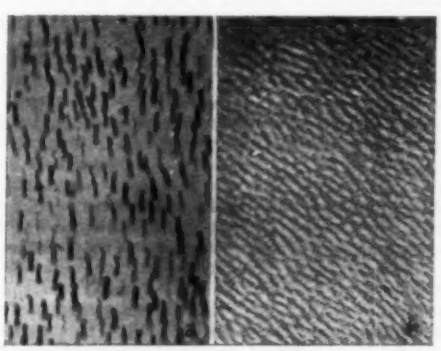


Fig. 2. (*a*) Staining of Tomes' fibres after treatment of decalcified section of human dentine with hydroxylamine followed by the Hotchkiss procedure. × 400. (*b*) Unstained fibres in sections not treated with periodate. × 400

method[9,10] also failed to stain these areas, it seems likely that metachromatic staining in this instance is misleading.

In interpreting these histochemical results, it must be remembered that only considerable local concentrations of polysaccharides are likely to stain deeply. The results do not exclude the possibility that polysaccharide is, in fact, distributed throughout the matrix of the tissues; but they suggest that, if so, its concentration is probably small.

Full details of the above work will be published elsewhere. The considerable and invaluable technical assistance of Mr. A. Parkinson is gratefully acknowledged. Acknowledgment is also made to Dr. D. H. Collins for supplying the samples of bone and to Mr. C. Woodhead and Mr. B. Townend for the extracted teeth.

H. J. Rogers

Biological Research Unit,
Dental School and Hospital,
Blundell Street,
Leeds 1.
April 26.

[1] Levene, P. A., "Hexosamines and Mucoproteins" (Longmans, Green and Co., London, 1925).
[2] Pincus, P., *Nature*, **161**, 1014 (1948).
[3] Partridge, S. M., *Biochem. J.*, **43**, 387 (1948).
[4] Morgan, W. T. J., and Elson, L. A., *Biochem. J.*, **27**, 1824 (1933).
[5] Somogyi, M., *J. Biol. Chem.*, **117**, 771 (1937).
[6] Clark, E. P., and Collip, J. B., *J. Biol. Chem.*, **63**, 461 (1925) (modified by S. Weidmann's unpublished observations).
[7] Martland, M., and Robison, R., *Biochem. J.*, **20**, 847 (1926).
[8] Hotchkiss, R. D., *Arch. Biochem.*, **16**, 131 (1948).
[9] Wislocki, G. B., Singer, M., and Waldo, C. M., *Anat. Rec.*, **101**, 487 (1948).
[10] McManus, J. F. A., *Nature*, **158**, 202 (1946).

Enzymic Inactivation of Serum Gonadotrophin

We have read with great interest the letter[1] appearing under this title in *Nature* of April 2, the contents of which we are able to corroborate from work dating from a year ago which was directed to the elucidation of the nature of the carbohydrate component of mare's serum gonadotrophin.

The enzyme preparation employed was a freeze-dried filtrate from *Clostridium welchii*, type *B*, kindly supplied by my colleague, Miss E. Bidwell, which Mr. M. V. Stack had found to possess the properties of destroying blood groups *A* and *O*. Such preparations contain also a proteolytic enzyme (the λ-antigen of Oakley, Warrack and Warren[2]) and a lethal toxin (*Cl. welchii* ε-toxin); *Cl. welchii* β-toxin was absent as the organisms had been grown on the medium of Adams and Hendee[3], in which *Cl. welchii* type *B* produces λ-enzyme, no β-toxin, and as much ε-toxin as is usually associated with *Cl. welchii* type *D*[4]. It also contained hyaluronidase and Stack and Morgan's polymerase, but no mucinase when tested against guinea pig intestinal mucosa by my colleague, Miss G. H. Warrack. Whitten does not state whether his enzyme preparation was tested for the presence of *Cl. welchii* toxins or proteolytic activity.

The enzyme preparation was adjusted with phosphate buffer of *p*H 7·0 to the original strength of the culture fluid (5 per cent solution w/v). The substrates were crude and purified mare's serum gonadotrophin (F.S.H.) assaying 3 I.U./mgm. and 1,000 I.U./mgm., and were adjusted to 200 I.U./ml. with physiological saline.

Aliquots of the hormone solutions were incubated for thirty minutes and overnight with an equal volume of (1) enzyme preparation which had been heated to 80° C. for 1 hr., a treatment known to destroy most enzymes; (2) the unheated enzyme preparation containing *A*- and *O*-destroying substances as well as λ-enzyme, the depolymerase of Stack and Morgan and hyaluronidase; (3) the unheated enzyme preparation with λ-enzyme inhibited by a titrated excess of normal horse serum[2]; (4) the enzyme preparation heated to 80° C., followed by the addition of the same amount of normal horse serum as in (3); (5) the enzyme preparation which had been held at 56° for an hour to eliminate the *A*-destroying substances. An azocoll test on this preparation[3] showed that λ-enzyme, too, had been destroyed. Heating to this temperature also destroys the depolymerase of Stack and Morgan[5].

After incubation, a titrated excess of antiserum to the lethal ε-toxin was added to all the test solutions before injection into rats for assessment of gonadotrophic activity in the usual manner. The results are tabulated in the accompanying table.

P.M.S. preparation dissolved in normal saline (I.U./mgm.)	Additions contained in an equal volume of phosphate buffer of *p*H 7·0	I.U./ml. after incubation at 37° C. for 30 min.	I.U./ml. overnight
3 1000	None	— —	100 87
3 1000	Enzyme preparation held at 80° C. for 1 hr.	100 80	90 90
3 1000	Unheated enzyme preparation	< 2 < 2	< 2 < 2
3 1000	Unheated enzyme preparation + normal horse serum	< 2 < 2	< 2 < 2
3 1000	Enzyme preparation held at 80° C. for 1 hr. + normal horse serum	100 78	96 70
3 1000	Enzyme preparation held at 56° C. for 1 hr.	< 2 < 2	< 2 < 2
Saline alone	Unheated enzyme preparation	< 2	< 2

It appears thus that *Cl. welchii* filtrates contain a substance or substances other than the *A*-splitting enzyme, the depolymerase of Stack and Morgan and the proteolytic λ-antigen, which are capable of destroying the gonadotrophic activity of pregnant mare serum within thirty minutes in the presence and absence of a large excess of serum protein. This other substance may be the *O*-splitting component or some other enzyme as yet unknown. Whitten has stated already that the hyaluronidase component is unlikely to be responsible, as testicular hyaluronidase does not destroy gonadotrophic activity. It should be noted in this connexion that Bussard and Eyquem[6] found that gonadotrophic activity was inhibited by anti-*A* sera, but not by anti-*O* sera. Their immunological findings thus do not corroborate Whitten's and our own results.

Chemically, blood-group substances and mare's serum gonadotrophin may have three components in common. Fleischer *et al.*[7] have reported the presence of acetyl glucosamine in pregnant mare serum. Recent analyses carried out in these Laboratories on highly

purified preparations indicated the presence of acetyl glucosamine. (We are grateful to Mr. A. Bennett for some of the acetyl estimations.) Possibly the carbohydrate component other than glucosamine was galactose[8] or a mixture of glucose and mannose[9]. Our more recent colorimetric analysis[10] indicated mannose and galactose, which, with acetylglucosamine and fucose, have been isolated from hydrolysates of blood group *A* substance[11].

It remains to be seen whether *Cl. welchii* filtrates will also affect chorionic and pituitary gonadotrophins.

R. Friedmann*

Wellcome Research Laboratories,
Beckenham, Kent.
May 6.

*Present address: British Chemicals and Biologicals, Ltd., Benger's, Ltd., Holmes Chapel, Cheshire.

[1] Whitten, W. K., *Nature*, **163**, 534 (1949).
[2] Oakley, C. L., Warrack, G. H., and Warren, M. E., *J. Path. Bact.*, **60**, 495 (1948).
[3] Adams, M. H., and Hendee, E. D., *J. Immunol.*, **51**, 249 (1945).
[4] Bidwell, E., unpublished results (1947).
[5] Stack, M. V., and Morgan, W. T. J., *Biochem. J.*, **43**, *Proc.* li (1948).
[6] Bussard, A., and Eyquem, A., *Ann. Inst. Pasteur*, **73**, 1194 (1947).
[7] Fleischer, G., Schwenk, E., and Meyer, K., *Nature*, **142**, 835 (1938).
[8] Li, C. H., Evans, H. M., and Wonder, D., *J. Gen. Physiol.*, **23**, 733 (1940).
[9] Gurin, S., and Hood, D. B., *J. Biol. Chem.*, **131**, 211 (1939).
[10] Friedmann, R., *Biochem. J.*, **44**, 117 (1949).
[11] Bray, H. G., Henry, H., and Stacey, M., *Biochem. J.*, **40**, 124 (1946).

Plastic Deformation of Glass during Scratching

Recently a short note by E. W. Taylor on plastic deformation of optical glass[1] has appeared. In this connexion a photomicrograph of scratches made on an ordinary microscope slide glass by a diamond is shown in Fig. 1. The diamond was shaped in the form of a cube with its faces parallel to cube planes and one cube corner was used as the scratching point, so that a body diagonal of the cube was perpendicular to the glass slide during scratching. In this position a (110) plane of the cube is also perpendicular to the slide, and the direction of scratching lies in this plane. The scratches, as reproduced, were made with an edge of the cube leading (the other possibility being that a face is leading). The angle between the cube edge and the plane of the glass slide was about 35° (ideal value 35° 16′).

The most remarkable feature of this micrograph is the appearance of turnings at the ends of the scratches. If it were not known that these scratches are made in glass, it might be supposed that they are formed in an ordinary plastic material. The turnings are curled like metal turnings and they show the same smoothness.

Another remarkable point is the observation that these turnings are only found at definite loads. In this particular test, no turnings were found for loads varying from 1 to 15 gm.; they occurred only at 20, 25 and 38 gm. At the highest load used, the turnings are not nearly so long as at the two lower loads applied, because they easily break into shorter pieces, as can be seen from Fig. 2.

In addition, no turnings were found if a cube face was leading during scratching. It may be that the wedge action of the cube edge, if this is leading, bears some relation to the formation of the turnings.

At the lower loads of 1–15 gm., only very fine chips were formed, and they are seen to be deposited

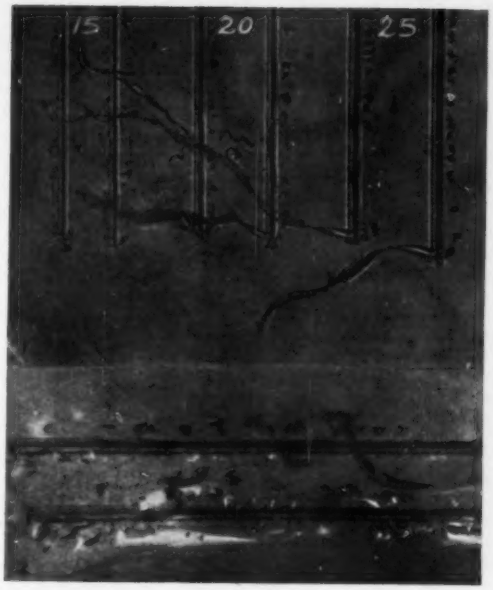


Fig. 1. Scratches made in glass by a diamond point. Magnification: × 385. Actual width of scratch 17·5 microns at load 25 gm.

Fig. 2. Scratch made in glass by a diamond point. Magnification: × 350. Load 38 gm.

along the side of the scratch. Such fine chips can also be seen, however, in those cases where turnings are formed. It appears as though two different processes have occurred. From the middle of the scratch a turning is removed, which is almost perfectly smooth (first process); at the edge of the scratch, however, that is, at the border line between turning and free glass surface, fine glass chips have been torn out (second process).

Due to an asymmetry of the scratching process, or of the scratching cube corner itself, chips are only deposited at one side of the scratch; the chips torn out from the other side can be seen sticking to one side of the turning, the other side of this turning being practically free from fine chips.

The turnings stand up from the glass surface a little, and in order to bring them sharply into focus the scratches themselves and the chips are somewhat diffuse, as is one of the turnings. The length of the longest turning is about 0·3 mm. and the length of the scratches is 0·7 mm.

These results appeared during the course of preliminary investigations of possible methods of distinguishing between diamonds of different hardness.

With respect to the formation of turnings and the plastic behaviour of glass under certain conditions, reference should also be made to research carried out by Ryschkewitsch[2].

J. F. H. Custers

Diamond Research Laboratory,
Industrial Distributors (1946), Ltd.,
44 Main Street,
Johannesburg.

[1] Taylor, E. W., *Nature*, **163**, 323 (1949).
[2] Ryschkewitsch, E., *Indust. Diam. Rev.*, **6**, 339 (1946).

Strength of Metals

In a recent letter under the above title, H. Lipson and A. R. Stokes[1] suggested that in my work on the subject I have not made sufficient mention of the contributions of themselves and co-workers to the interpretation of X-ray line-broadening from deformed metals.

I have not done so before because all their published work has been on metals which have been deformed by the rough-and-ready process of filing, and has been confined to the examination of the irregular filings so produced. When an engineer thinks of the problem of the deformation and strength of metals, he does so in terms of *solid* metal systematically deformed by recognized mechanical tests or by standard modes of fabrication. Therefore, as a serious contribution to the problem I have regarded their results as irrelevant, and their assumption that the findings on filings can be applied unmodified to normal metal as unsound.

For the same reason I have not before considered it necessary to comment on their further contention that the line-broadening as interpreted by them is related to the yield strength of metals. It is well known that the yield and ultimate strength of metals depend greatly on the method of deformation and testing. It is sufficient of a problem to understand the effects of normal tests without adding the somewhat unreal case of metal filings.

For curiosity we have compared the X-ray effects from filings and solid metal and find no systematic relation. This observation is referred to in fuller papers on the wider subject which have recently been published by the Institute of Metals[2,3]. The papers are still open for discussion, and if Dr. Lipson and Dr. Stokes wish to make a contribution I should be pleased to comment further.

W. A. Wood

Baillieu Laboratory,
University, Melbourne.

[1] Lipson, H., and Stokes, A. R., *Nature*, **163**, 871 (1949).
[2] Wood, W. A., and Rachinger, W. A., *J. Inst. Metals* (March 1949).
[3] Wilms, G. R., and Wood, W. A., *J. Inst. Metals* (April 1949).

The main difference between Dr. Wood and ourselves seems to lie in our interpretation of the functions associated with a physicist. We believe that a physicist should be concerned with splitting a problem into its essentials and dealing with them separately, whereas the engineer should deal with immediate problems in their entirety. One is familiar with the accusation that physicists are too far removed from reality to be of practical use; one does not expect this accusation to be repeated by another physicist such as Dr. Wood.

Our experiments on filings were conducted in this light. We believe that filings are simpler to deal with theoretically than massive metal, because any effects on them are more likely to average out; as a parallel, the dynamics of a large number of particles can be handled although the three-body problem is insoluble. We do not claim that our results are complete, but merely that they provide important evidence in considering the more complicated state of affairs in massive metal.

We are aware of the recent papers to which Dr. Wood refers, but to undertake an answer to them would necessitate further experimental work for which we are not equipped. We would, however, refer to one major point: we cannot accept the contention that it is possible for an appreciable volume of metal, *plastically* deformed, to be in a state of uniform stress.

Finally, we would point out that we did not direct attention only to our own work, as Dr. Wood states; two other schools were included in the references we gave. Moreover, so far as we are aware, no other workers have found it possible to support Dr. Wood's results. We recognize, however, that no single type of experiment can be conclusive, and we would suggest that the interests of the subject might be better served by the exploration of other methods of experimentation, such as micro-techniques, rather than by the measurement of line-breadths only. Dr. Wood's own results, published in 1932 [1], illustrate perfectly how deceptive the measurement of one or two lines on a back-reflexion photograph can be.

H. Lipson

Department of Physics,
College of Technology,
Manchester.

A. R. Stokes

Wheatstone Physics Laboratory,
King's College,
London, W.C.2.

[1] *Nature*, **129**, 760 (1932).

Origin of Hygroscopicity of Jute

Jute is reported[1] to be characterized by high values of moisture adsorption and heat of wetting. From a study of the adsorption isotherms and heats of wetting of a series of cellulose fibres including cotton, ramie and rayons, Hermans[2] has concluded that greater hygroscopicity of rayons relative to pure cellulosic native fibres is due to the presence of a correspondingly greater quantity of amorphous cellulose. The results of his X-ray method[2] of quantitative evaluation of the crystalline fraction check well with his findings from adsorption isotherms and heats of wetting.

Relative humidity (per cent)	Sorption ratio	
	Adsorption	Desorption
15	1·60	1·40
30	1·70	1·45
45	1·60	1·50
60	1·65	1·55
75	1·60	1·57
85	1·60	1·55
Average	1·60	

The average sorption ratio of jute calculated from the published results for cotton[4] and jute (see table) is 1·60. The heat of absorption of jute at zero regain calculated from the heat of wetting – regain curve by extrapolation is 228 cal./gm. water, which is nearly the same value as reported by Rees[5] for cotton, rayon, etc. It appears, therefore, that the greater hygroscopicity of jute can be attributed to the capacity factor, on account of a greater quantity of amorphous constituents in polyuronides, xylan, hexosan and lignin in the fibre. If this view is correct, the ratio of the integral heats of wetting at zero regain of cotton and jute should be equal to the

sorption ratio. Using the recent figure for the heat of wetting of cotton due to Rees and that of jute due to Macmillan, Mukherjee and Sen, the ratio is 18·4/11·0 = 1·7, which is again very near the value calculated from the adsorption isotherm.

In recent work[6], we have found that the proportion of crystalline cellulose (expressed as a percentage of α-cellulose) is the same in jute and other pure cellulosic native fibres. Now the average constituents of jute[7] have been given as: α-cellulose, 61 per cent; polyuronides, 4·5 per cent; xylan, 11·6 per cent; hexosan, 12·3 per cent; and lignin, 10·6 per cent. Calculating on the basis of 30 per cent amorphous cellulose in all the purer native fibres as reported by Hermans, and assuming all non-cellulosic constituents other than lignin to be identical with amorphous cellulose so far as the X-ray scattering is concerned, the proportion of amorphous constituents in jute is 46·7 per cent, composed of 18·3 per cent α-cellulose and 28·4 per cent non-cellulosic amorphous constituents besides lignin. Therefore the ratio of amorphous constituents of jute and cotton is 46·7/30·0 = 1·56. Remembering that there is the possibility of a small contribution in this regard due to lignin, some proportion of which may form a chemical combination with other non-cellulosic constituents, the agreement is reasonably good. It appears, then, that the greater hygroscopicity of jute is almost wholly due to polyuronides, xylan and hexosan. That the major part of lignin is inactive as regards moisture absorption is again indicated in the inappreciable change in the swelling behaviour of jute[8] on delignification up to 0·5 per cent lignin.

M. K. Sen

Indian Jute Mills Association,
Research Institute,
Calcutta.

P. H. Hermans

Instituut voor Celluloseonderzoek,
Utrecht.

April 21.

[1] Macmillan, Mukherjee and Sen, *J. Text. Inst.*, **37**, T13 (1946).
[2] Hermans, "Contribution to the Physics of Cellulose Fibres" (Elsevier, Amsterdam–New York, 1946).
[3] Hermans and Weidinger, *J. App. Phys.*, **19**, 491 (1948).
[4] Urquhart and Williams, *J. Text. Inst.*, **15**, T138 (1924).
[5] Rees, *J. Text. Inst.*, **39**, T351 (1948).
[6] Sen and Hermans, *Rec. Trav. Chim. des Pays-Bas* (in the press).
[7] Sarkar, Majumdar and Pal, *J. Text. Inst.*, **39**, T44 (1948).

Goethe and Colour

The scope of Prof. Andrade's recent essay on Goethe[1] is so broad that a few points meriting more detailed attention appear to have escaped his pen. It might easily lead to misunderstandings, were one to insist on more than a superficial similarity between Goethe and Aristotle. He himself admitted that he was a keen follower of Plotinus, and, as Speiser[2] has observed, his approach to the problem of colour is Neo-Platonic. The major Neo-Platonic thinkers—Dante, Kepler, Goethe—were rather unfortunate in their researches because of the poor opinion they held of mathematics; Kepler's laws were a mere by-product of his attempt at discovering the cosmic harmony. A rather important divergence from classical principles is the apparent rejection of the idea of the excluded mean. Just as Dante thinks of the world as embedded between the extremes of heaven and hell, separated by definite categories each of which shares something with its two neighbours, and the Neo-Platonists, in general, made definite steps between matter and idea, so Goethe thinks of light as separated from darkness, the colours stepping between the two. So far as his relation to Newton is concerned, it is similar to that of Kant to Hume. English objectivity provoked the Germans, and gave rise to the "Critique of Pure Reason" in philosophy and "Zur Farbenlehre" in science.

There are two, more specific, points which ought to be mentioned. Much though he delights in the sensation of colour, Goethe associates with it something primitive. Consequently, red Indians and children adore wild hues, as do white adults who lack culture. This idea is, of course, in keeping with Neo-Platonism, since light (white) is on a higher level than colour. But Goethe applies it to evolution, too. Thus he writes (par. 666): "Some monkeys have certain parts of their anatomy coloured with elementary hues: this demonstrates how remote such a creature is from perfection. . . ." One can obviously retort that the white goose—how near to perfection in Goethe's colour scheme—is less intelligent than such a partly coloured monkey. This, however, is not the point. Goethe drives on to the logical conclusion (par. 672): "As a result of all that has been said so far we take the liberty of affirming that the white man, i.e., one whose skin tends from white to yellowish, brownish, reddish, in short, one whose surface appears to be the most indifferent, and the least inclined to anything in particular, we say that such a human being is the most beautiful". This is a white man's judgment; very little imagination is needed to claim that the most beautiful is also the best, and the nucleus is given for a racial theory.

Some of Goethe's ideas, on the other hand, were fruitful. Thus it may not be wrong to suppose that Hering's scale of greys[3] is a result of Goethe's observation (par. 250). There is also the temptation to link Hering's theory of colour vision with Goethe's ideas. The poet calls red and yellow the positive, green and blue the negative hues. Yellow and blue, and green and red respectively are classed together. White and black are separate concepts. A similar scheme underlies Hering's theory. There are three substances: white-black, yellow-blue, red-green. He assumes that dissimilation (=positive) of each substance produces the former, and assimilation (=negative) the latter partner of each couple. In view of Granit's discovery[4] of brightness receptors in the retinæ of several animals, it may well be that Hering's ideas, condemned as being of historic interest only, are going to be resuscitated. Should Goethe share the credit? Moses is not credited with the discovery of the law of the equivalence of mass and energy in spite of light being the first object of creation: although he may have inspired it, the unscientific Goethe cannot take credit for a theory of vision just because one of his many shots may prove to be a lucky hit.

R. Weale

Vision Research Unit,
Institute of Ophthalmology
(University of London),
London, W.C.1.

Sept. 12.

[1] Andrade, *Nature*, **164**, 338 (1949).
[2] Speiser, "Die mathematische Denkweise" (Verlag Birkhäuser, Basle, 1945).
[3] Southall, "Introduction to Physiological Optics", 395 (Oxford Univ. Press, 1937).
[4] Granit, "Sensory Mechanism of the Retina", 271 (Oxford Univ. Press, 1947).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 10

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Structure of Peripheral Nerve".*
(Further Lecture on October 17.)

UNIVERSITY OF LONDON (at Westfield College, Hampstead, London, N.W.3), at 5.15 p.m.—Rt. Hon. Walter Eliot: "Questions and Answers in Colonial Education".*

INSTITUTION OF ELECTRICAL ENGINEERS (at the Great Western Hotel, Reading), at 7 p.m.—Mr. R. H. Abell: "Some Engineering Features of the British Grid System".

Tuesday, October 11

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Some Modern Views on Evolution".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. G. A. Wainwright: "The Coming of Iron to the Bantu".

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. W. Rutherford and Mr. K. Ruschin: "The Preparation of Ammonia Synthesis Gas from Wood Fuel in India".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. J. N. Aldington: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Discussion on "Recent Progress in the Chemistry of Phenolic Resins" (to be opened by Mr. S. R. Finn, Dr. N. J. L. Megson and Mr. E. J. Whittaker).

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. M. Stacey: "Biological Polymerisation with Special Reference to Polysaccharide Synthesis".

ROYAL STATISTICAL SOCIETY, TEES-SIDE GROUP OF INDUSTRIAL APPLICATIONS SECTION (at the William Newton School, Norton, Stockton), at 7.15 p.m.—Mr. T. A. Evans: "Operational Research in War and its Extension to Industry".

Wednesday, October 12

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. A. W. Jarman: "Bitumen Horizons".*

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGICAL PANEL OF THE FOOD GROUP (in the Large Hall, Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Papers on "Aspects of the Mineral Metabolism of Micro-organisms".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Community Centre, Slough), at 7.15 p.m.—Dr. E. C. Wood: "Quantitative Common-Sense and the Chemist".

UNIVERSITY OF LONDON (at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Mr. T. Burton Brown: "Recent Fieldwork in the Near and Middle East, 1, Explorations and Excavation in Northern Iran".*
(Further Lectures on October 19, 26, November 2, 9, 16, 23, 30, December 7 and 14.)

Thursday, October 13

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Sir John S. Buchanan: "The Time Scale in Aeronautical Engineering" (Presidential Address).

Friday, October 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Otto Struve: "Spectroscopic Binaries" (George Darwin Lecture).

CHEMICAL SOCIETY, EXETER BRANCH (joint meeting with the UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Washington Singer Laboratories, Prince of Wales Road, Exeter), at 5 p.m.—Dr. Kathleen Lonsdale, F.R.S.: "Diffraction of Neutrons by Crystals".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. Gertrude M. Cox: "The Organisation and Functions of the Institute of Statistics of the University of North Carolina".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Application of Psychological and other Tests to the Selection of Students for Courses and to Vocational Guidance" (to be opened by Mr. D. Smith).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle upon Tyne), at 6.15 p.m.—Mr. Mungo Campbell: Presidential Address; Mr. J. A. H. Paffett: "Application of Photo-Elastic Methods to Ship Design".

ROYAL STATISTICAL SOCIETY, SOUTH WALES GROUP OF INDUSTRIAL APPLICATIONS SECTION (at the Technical College of Monmouthshire, Crumlin), at 7 p.m.—Dr. J. W. Cox: "The Use of Statistics in Psychological Testing".

Saturday, October 15

NUTRITION SOCIETY (in the Department of Pharmacology, The University, Birmingham), at 1.15 p.m.—Prof. A. C. Frazer, Dr. J. Elks, Dr. J. M. French, Prof. T. P. Hilditch, F.R.S., and Prof. P. Kraut: "Triglyceride Fats in Human Nutrition".

BRITISH PSYCHOLOGICAL SOCIETY (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. Ernest Beaglehole: "The Concept of Character Structure and its Value in Socio-psychological Analysis".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER IN THE DEPARTMENT OF METALLURGY, County Technical College, Wednesbury—The Director of Education (Dept. F.E.), County Education Offices, Stafford (October 15).

SENIOR ASSISTANT IN CHEMISTRY, a SENIOR ASSISTANT IN BIOLOGY, and a GRADUATE ASSISTANT IN ENGINEERING—The Principal, Stockport College for Further Education, Stockport (October 15).

SENIOR TECHNICIAN IN THE PATHOLOGY DEPARTMENT at Neath General Hospital—The Secretary, Mid-Glamorgan Hospital Management Committee, 8 Wind Street, Neath (October 15).

LECTURER IN BACTERIOLOGY in the Department of Pathology—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (October 24).

SENIOR and/or JUNIOR ORGANIC CHEMISTS, British West Indies Sugar Research Scheme, Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (October 29).

CHIEF ENGINEER, a SUPERINTENDING ENGINEER, and a MECHANICAL ENGINEER, for Land Reclamation work in India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 459A (October 31).

ASSISTANT LECTURERS or LECTURERS IN MATHEMATICS, AGRICULTURAL ORGANISATION AND ECONOMICS, and AGRICULTURAL CHEMISTRY, at the Gordon Memorial College, Khartoum—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (November 1).

PHYSICISTS (with good honours degree or equivalent with post-graduate experience an advantage) at Ministry of Supply establishments in Southern England—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.231/49BN (November 5).

READERSHIP IN APPLIED PHYSIOLOGY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 30).

SENIOR LECTURER and a LECTURER IN BIOCHEMISTRY, and a LECTURER IN PHILOSOPHY, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, November 30).

LECTURER IN MATHEMATICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

LECTURER IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

LECTURER IN BIOLOGY, to take classes up to Final Degree standard in Zoology and/or Botany—The Director of Education, The Polytechnic, Regent Street, London, W.1.

LECTURER IN PHYSICS (to final B.Sc. standard)—The Organiser of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby.

ENGINEER-GEOLOGISTS (2) to carry out investigations for the location of sub-surface water supplies by boring shallow wells, etc., Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27079/2.

TECHNICIAN (male or female) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

CHIEF TECHNICIAN (with special knowledge of hæmatological, serological and bacteriological techniques), and TECHNICIANS—The Medical Director, National Blood Transfusion Association, 52 Lower Leeson Street, Dublin.

SENIOR LABORATORY TECHNICIAN IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool.

LABORATORY DEMONSTRATORS IN THE DEPARTMENT OF AIRCRAFT PROPULSION—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

B.I.O.S. Overall Report No. 16: The Railways of Germany during the Period 1939–1945. By H. Holcroft. Pp. 72. (London: H.M. Stationery Office, 1949.) 3s. net. [48

British Institute of Management. Winter Proceedings 1948–49, No. 5: Management's Requirements of the Accounting System. By R. E. Yeabsley. Pp. 27. (London: British Institute of Management, 1949.) 2s. 6d. [48

American and Canadian Libraries: some Notes on a Visit in the Summer of 1947. By J. H. P. Pafford. Pp. vi+42. (London: Library Association, 1949.) 4s.; to Members, 3s. [48